SOIL SURVEY
La Moure County and Parts of James River Valley North Dakota

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1956–1962. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the Area in 1966. This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the La Moure County Soil Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for agriculture, industry, and recreation.

Locating Soils

All the soils of La Moure County and parts of the James River Valley are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the Area in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit and range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions, the capability unit descriptions, and the discussions of the range sites.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in this survey Area will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information.

Cover: Aerial view in the Barnes-Svea association. This area is in La Moure County.

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SOIL SURVEY OF LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

THIS SURVEY AREA, in the southeastern part of North Dakota (fig. 1), consists of all of La Moure County and parts of Stutsman County to the north and Dickey County to the south. The James River flows south by southeast through these three counties. La Moure County has an area of 727,680 acres, or about 1,137 square miles. In addition to La Moure County, the survey Area covers 11,673 acres in the James River Valley in Stutsman County and 84,737 acres east of the James River in Dickey County.

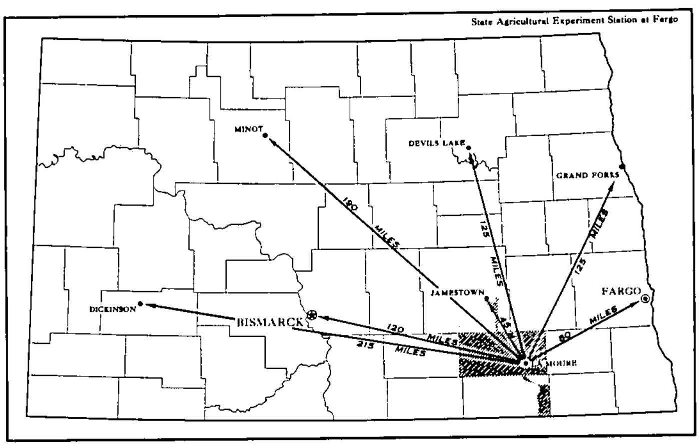

Figure 1.—**Location of La Moure County and Parts of James River Valley in North Dakota.**

About 98 percent of the land area is farmed, and about three-fourths of this is used for crops. Spring wheat, oats, barley, rye, flax, corn, and alfalfa are the principal crops.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in La Moure County and parts of the James River Valley, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the area, they observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series (*13*)[2]. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Barnes and Svea, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Hecla loamy fine sand is one of several phases within the Hecla series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

[1] Assisting with the fieldwork were P. T. CAMPBELL, ELDON H. EVENSON, LLOYD L. JOOS, DONALD E. KERL, and WESLEY M. LARSEN, Soil Conservation Service; and L. G. BRANTNER, O. P. OLSON, D. D. PATTERSON, and F. W. SCHROER, North Dakota Agricultural Experiment Station.

[2] Italicized figures in parentheses refer to Literature Cited, p. 117.

A comparison of the detailed soil map of this Survey Area with that of adjoining areas of Sargent County will show a few places where soil boundaries that overlap county lines between Sargent County and Dickey County do not match perfectly. These few differences arise because the soil mapping in Dickey County (a part of this soil survey) was at a higher intensity than that in Sargent County and, consequently, more kinds of soil are shown in Dickey County and soil areas are smaller. In addition, symbols differ slightly in a few places because continuing refinement of the soil classification system has resulted in some changes in classification by soil series. For example, the Tonka series of this survey is the same as the Tetonka series of the Sargent County soil survey.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of La Moure County and parts of the James River Valley: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Barnes-Svea loams, undulating, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Fargo and Hegne silty clays is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Gravel pits is a land type in La Moure County and parts of the James River Valley.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations in La Moure County and parts of the James River Valley. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The fifteen associations in this Survey Area are discussed in the following pages.

1. Barnes-Svea-Parnell association

Undulating to rolling, well drained and moderately well drained, medium-textured soils on glacial uplands; and poorly drained, moderately fine textured soils in enclosed morainic depressions

This association consists of well drained and moderately well drained soils on glaciated uplands and of poorly drained soils in scattered depressions. It occurs on undulating to rolling topography in the western part of La Moure County. The enclosed depressions range from less than 1 acre in size to nearly 200 acres. This association makes up about 20 percent of the Survey Area.

Barnes and Svea soils are the most extensive of the upland soils, and Parnell soils are the main soils in the depressions.

Barnes soils make up about 55 percent of the association, Svea soils about 25 percent, and Parnell soils about 8 percent. Barnes and Svea soils, which formed in glacial till, are deep, dark colored, and medium textured. Barnes soils are well drained, and Svea soils are moderately well drained. Barnes soils generally occupy low knolls and rolling upper slopes. Svea soils, which are on lower slopes and in level areas, have a thicker surface layer than

Barnes soils. Parnell soils are deep, dark colored, poorly drained, and moderately fine textured.

Other soils in this association are of the Buse, Cresbard, Cavour, Nutley, Grano, and Colvin series. Buse soils are on hillsides, and Nutley soils are on lower slopes and in intervening level areas. Cresbard and Cavour soils occupy level and slightly depressed positions below Barnes and Svea soils. Grano and Colvin soils are in depressions. Buse soils are excessively drained. They have a thin surface layer. Cresbard and Cavour soils are dark colored and medium textured, and they have a claypan. Nutley soils are deep, moderately well drained, and fine textured. They developed in glacial lake sediments. Grano and Colvin soils are poorly drained and calcareous.

About 80 percent of this association is cultivated. The main crops are spring wheat, oats, barley, rye, flax, alfalfa, and tame grasses. Nearly all of the poorly drained areas and most of the steep areas are used for hay and pasture. The farms in this association are diversified, and most farmers depend on the sale of grain and livestock for their income.

2. *Renshaw-Lamoure-Exline association*

Nearly level, well-drained, medium-textured soils, moderately deep to coarse sand and gravel; and moderately fine textured, poorly drained soils; on dissected outwash plains

This association consists chiefly of level, well-drained and poorly drained soils on a narrow, outwash plain that is dissected by numerous intermittent streams and drainageways. It is in the western part of La Moure County. This association makes up about 1 percent of the Survey Area.

The soils of this association developed in glacial outwash and in alluvium. Renshaw soils make up about 60 percent of the association, Lamoure soils about 15 percent, and Exline soils about 15 percent. Renshaw soils, which occur as broad areas, are well drained, dark colored, and medium textured. They are moderately deep to coarse sand and gravel. Lamoure soils, which are on bottom lands, are deep, dark colored, and moderately fine textured. They are poorly drained, have a seasonally high water table, and are susceptible to flooding. Exline soils occupy slight depressions on outwash plains and bottom lands. They have a thin surface layer and a slowly permeable claypan. The lower part of their subsoil contains accumulated salts.

Other soils in this association are of the Borup, Colvin, Divide, Sioux, Ludden, and Rauville series. Borup and Colvin soils are poorly drained and calcareous. They occur in seepage areas and shallow depressions. Divide soils are moderately deep and calcareous. They are underlain by coarse sand and gravel. Sioux soils are shallow over gravel. Ludden soils, which occur on bottom lands, are fine textured. Rauville soils, which occur in stream channels, are very poorly drained.

About 60 percent of this association is cultivated, and the rest is used for pasture and hay. Renshaw soils are more extensively cultivated than other soils in this association. Nearly all the bottom-land areas are used for native pasture and hay. Most of the farms are diversified. Livestock raising and the production of grain are the main enterprises.

3. *Barnes-Svea association*

Nearly level to undulating, well drained and moderately well drained, medium-textured soils on glacial uplands

This association consists mainly of well drained and moderately well dained soils on glacial till plains, but there are poorly drained soils in scattered enclosed depressions. The depressions range from less than 1 acre to about 50 acres in size. This association consists of the major part of the eastern two-thirds of La Moure County, except areas in the James River Valley and smaller areas elsewhere. It makes up about 53 percent of the Survey Area.

Barnes soils make up about 50 percent of the association, and Svea soils about 35 percent. These soils, which formed in glacial till, are deep, dark colored, and medium textured. Barnes soils are well drained, and Svea soils are moderately well drained. Barnes soils are the dominant soils on undulating uplands, and Svea soils are the dominant soils in the nearly level areas.

Other soils in this association are mainly of the Hamerly, Vallers, Cresbard, Cavour, Parnell, and Tonka series. Hamerly soils are deep, moderately well drained, upland soils that have a calcareous surface layer and subsoil. Vallers soils are poorly drained and calcareous. Cresbard and Cavour soils are shallow to moderately deep. They have a slowly permeable claypan. Parnell and Tonka soils occur in depressions. They are poorly drained.

Most of this association is cultivated. The soils are among the most productive in the Survey Area. The main crops are wheat, oats, barley, rye, flax, corn, alfalfa, and tame grasses. The wetter soils in depressions are generally used for native pasture and hay, but some areas have been drained and cultivated.

4. *LaPrairie-Eckman-Renshaw-Fordville association*

Nearly level and gently sloping, moderately well drained and well drained, medium-textured soils of the James River Valley

This association occurs on bottom lands, terraces, and lower side slopes in the James River Valley, in Stutsman County. It makes up about 1 percent of the Survey Area.

LaPrairie soils make up about 40 percent of the association, Eckman soils about 25 percent, Renshaw soils about 18 percent, and Fordville soils about 12 percent. All of these soils have a dark-colored, medium-textured surface layer. LaPrairie soils, which formed in recent alluvium, are deep, moderately well drained, bottom-land soils. Eckman soils, which formed in silty deposits left by glacial melt water, are deep, well-drained soils on gentle side slopes. Renshaw and Fordville soils are moderately deep to coarse sand and gravel. They are well drained. Fordville soils occur on terraces in higher positions than LaPrairie soils. They are deeper over gravel than Renshaw soils.

Other soils in this association are of the LaDelle, Gardena, Glyndon, Bearden, Divide, Sioux, Arvilla, and Rauville series. LaDelle and Gardena soils are deep, dark colored, and moderately well drained. They occur on low terraces and on alluvial fans. Glyndon, Bearden, and Divide soils are somewhat poorly drained to moderately well dained. They have a limy surface layer and subsoil. Sioux soils are shall to sand and gravel and are exces-

sively drained. Arvilla soils are moderately deep to sand and gravel. They are well drained and moderately sandy. Rauville soils, which occur in channels and seepage areas, are very poorly drained.

About 85 percent of this association is cultivated. The main crops are corn, small grain, and alfalfa. The deep soils in this association are among the most productive in the Survey Area. Most farms are diversified. Livestock and the production of grain are the main enterprises.

5. Buse-Eckman-Renshaw-LaPrairie association

Steep to nearly level, excessively drained to moderately well drained, medium-textured soils of the James River Valley

This association consists of excessively drained to moderately well drained soils on terraces and bottom lands along the James River, in La Moure County. This association makes up about 3 percent of the Survey Area.

Buse soils make up about 25 percent of the association, Eckman soils about 20 percent, Renshaw soils about 20 percent, and LaPrairie soils about 10 percent. Buse soils, which developed in glacial till, are thin and excessively drained. They occur on steep side slopes. Eckman soils, which developed in silty deposits left by glacial melt water, are deep, well drained, and medium textured. They occur on lower side slopes, terraces, and alluvial fans. Renshaw soils, which occur on terraces, are moderately deep to coarse sand and gravel. They are medium textured. LaPrairie soils, which formed in recent alluvium, are deep, dark colored, and moderately well drained. They occur on bottom lands along the James River. Most areas of LaPrairie soils are level, but some areas are dissected by old stream channels.

Other soils in this association are mainly of the LaDelle, Gardena, Fordville, Sioux, and Arvilla series. LaDelle and Gardena soils, which are on bottom lands and terraces, are deep, dark colored, and moderately well drained. Fordville soils are moderately deep to sand and gravel. They are deeper than Renshaw soils. Sioux soils are shallow over gravel and excessively drained. Arvilla soils are sandy and are underlain by gravel.

About 75 percent of this association is cultivated. The main crops are wheat, oats, barley, flax, corn, and alfalfa. The deep soils are among the most productive in the Survey Area. Most areas on steep side slopes are used for native pasture.

6. Cresbard-Cavour association

Level, moderately well drained and somewhat poorly drained, medium-textured soils that are moderately deep and shallow to claypans; on glacial till plains

This association occurs on glacial till plains in the northeastern part of La Moure County. Some of the areas are in slight depressions. The association makes up less than 1 percent of the Survey Area.

Cresbard soils make up about 35 percent of the association, and Cavour soils about 25 percent. Cresbard soils are moderately well drained. They have a medium-textured surface layer; their subsoil contains a slowly permeable claypan. There are a few salt crystals in the underlying material. Cavour soils are somewhat poorly drained. Their surface layer is thin, and they have a slowly permeable claypan in the subsoil. The lower part of the subsoil contains many salt crystals.

Other soils in this association are of the Svea, Hamerly, Parnell, and Tonka series. Svea and Hamerly soils, which occur on uplands, are deep, medium textured, and moderately well drained. Svea soils are dark colored; Hamerly soils are light gray in color and have a high content of lime. Parnell and Tonka soils, which occur in enclosed depressions scattered throughout the Area, are poorly drained.

About 60 percent of this association is cultivated, but the claypan restricts roots and penetration of moisture. The main crops are small grain and alfalfa. Wet areas are generally used for hay and pasture.

7. Buse-Barnes association

Steep to rolling, excessively drained to well-drained, medium-textured soils on morainic hills

This association consists mainly of excessively drained to well-drained soils on morainic hills. Poorly drained soils occur in scattered enclosed depressions. The topography is rolling to steep. The enclosed depressions range from less than 1 acre to nearly 200 acres in size. This association makes up about 3 percent of the Survey Area.

Buse soils make up about 45 percent of the association, and Barnes soils make up about 40 percent. These are medium-textured soils that formed in glacial till. Buse soils, which generally occur on steep hillsides and side slopes, are excessively drained. They have a thin, dark-colored surface layer and a grayish-brown, calcareous subsoil. Barnes soils, which occur downslope from Buse soils, are undulating to rolling. They have a thicker surface layer than Buse soils.

Other soils in this association are of the Svea, Nutley, Sioux, Renshaw, Parnell, and Grano series. Svea soils are nearly level. They occur downslope from Barnes soils. These soils, which developed in glacial till, are deep, dark colored, moderately well drained, and medium textured. Nutley soils are level and gently sloping. These soils, which developed in glacial lake sediments, are deep, well drained, and fine textured. Sioux and Renshaw soils occur on uplands. They are underlain by gravel. Parnell and Grano soils, which occur in depressions, are deep and poorly drained to very poorly drained.

About 65 percent of this association is in native grasses. The milder slopes are cultivated, but the steeper and wetter areas are used for pasture and hay. Farmers depend mainly on the sale of livestock for their income.

8. Fargo-Nutley association

Nearly level to gently sloping, poorly drained to moderately well drained, fine-textured soils on old glacial lake plains

This association consists of nearly level to gently sloping soils on lake plains in the southwestern part of La Moure County. Generally, the soils have good surface drainage, but there are several deep, intermittently wet, flat basins scattered throughout the association. These basins range from 50 to 200 acres in size. This association makes up less than 1 percent of the Survey Area.

Fargo soils make up about 50 percent of the association, and Nutley soils about 40 percent. These soils formed in

fine-textured glacial deposits. They are deep, dark colored, and fine textured. Fargo soils occur in slightly lower positions than Nutley soils. They are poorly drained and are ponded for short periods after heavy rainfall. Nutley soils are moderately well drained.

Other soils in this association are of the Overly, Great Bend, Hegne, and Grano series. Overly and Great Bend soils are deep, dark colored, and moderately fine textured. Overly soils are moderately well drained, and Great Bend soils are well drained. Hegne soils are deep, somewhat poorly drained, fine-textured soils that have a high content of lime. Grano soils are deep, very poorly drained, calcareous soils in intermittently wet basins. They are fine textured.

About 80 percent of this association is cultivated. These are among the most productive soils in the Survey Area. The main crops are small grain, flax, and alfalfa. Nearly all the acreage in the intermittently wet basins is used for native grass pasture and hay.

9. Edgeley association

Nearly level to undulating, moderately well drained and well drained soils formed in glacial till; moderately deep and deep to shale

This association consists of well drained and moderately well drained, medium-textured soils on glacial till plains in La Moure County. The association is dissected by several small streams. It makes up less than 1 percent of the Survey Area.

Edgeley soils, which are moderately deep to deep and dark colored, make up about 80 percent of the association. These soils formed in shaly glacial till. Shale occurs at a depth of 2 to 5 feet.

Other soils in this association are mainly of the Barnes, Cavour, Cresbard, Tonka, and Exline series. Barnes soils, which formed in glacial till, are deep, well drained, and medium textured. Cavour and Cresbard soils also formed in glacial till, but they have a claypan. These soils occupy nearly level to slightly depressed positions on uplands. Tonka soils are deep and poorly drained. They occur in shallow, closed depressions scattered throughout the association. Exline soils, which formed in deposits left by glacial melt water, occur on stream terraces and bottom lands. They have a claypan.

In this association most of the upland areas are cultivated. The principal crops are wheat, barley, oats, rye, flax, corn, and alfalfa. The soils on bottom lands and stream terraces are used for native pasture and hay. The farms in this association are diversified. Production of grain and raising of livestock are the main enterprises.

10. Barnes-Cresbard association

Nearly level to undulating, medium-textured, well drained soils and level, moderately well drained and somewhat poorly drained soils that are moderately deep to a claypan; on glacial till plains

This association occurs on nearly level to undulating glacial till plains in the southwestern part of La Moure County. It is dissected by several small streams, and there are many scattered, poorly drained, shallow depressions. This association makes up about 4 percent of the Survey Area.

Barnes soils make up about 50 percent of the association, and Cresbard soils make up about 30 percent. These soils formed in glacial till. Barnes soils, which are nearly level to undulating, occur on uplands. They are deep, medium textured, and well drained. Cresbard soils occupy level and slightly depressed positions below Barnes soils. They have a medium-textured surface layer and a slowly permeable claypan subsoil. The lower part of the subsoil generally contains a few salt crystals.

Other soils in this association are mainly of the Svea, Tonka, and Cavour series. Svea soils occur on lower slopes. They are deep, moderately well drained, and medium textured. Tonka soils, which occur in shallow depressions, are poorly drained. Cavour soils have a thin surface layer overlying a slowly permeable claypan.

About 80 percent of this association is cultivated. Small grain, flax, and alfalfa are the main crops. The farms in this association are mainly diversified, and the farmers depend on the sale of grain and livestock products for their income.

11. Embden-Gardena association

Nearly level, moderately well drained, moderately coarse textured and medium-textured soils on glacial till plains

This association consists of moderately well drained, loamy soils on upland plains in the south-central part of La Moure County. This association makes up about 1 percent of the Survey Area.

Embden soils make up about 45 percent of the association, and Gardena soils about 40 percent. These soils, which formed in deposits left by glacial melt water, are underlain by till at a depth of 2 to 5 feet. They are deep, dark colored, and moderately well drained. The topography ranges from nearly level to undulating. Embden soils have a moderately coarse textured surface layer and subsoil. Gardena soils have a medium-textured surface layer and subsoil.

Other soils in this association are mainly of the Barnes, Egeland, Tiffany, and Venlo series. Barnes and Egeland soils, which are on undulating upper slopes, are deep, dark colored, and well drained. Barnes soils, which formed in glacial till, are medium textured. Egeland soils developed in moderately coarse deposits left by glacial melt water. Tiffany and Venlo soils occur in small depressions scattered throughout the Area. Tiffany soils are poorly drained, and Venlo soils are very poorly drained.

About 85 percent of this association is cultivated. The main crops are small grain, flax, and alfalfa. The farms are mainly of the diversified grain and livestock type.

12. LaDelle-Lamoure-Ludden-Ryan association

Nearly level, moderately well drained to poorly drained, medium-textured to fine-textured soils on bottom lands

This association occurs on bottom lands along the James River, in La Moure and Dickey Counties. It makes up about 3 percent of the Survey Area.

LaDelle soils make up about 25 percent of the association, Lamoure soils about 20 percent, Ludden soils about 20 percent, and Ryan soils about 10 percent. LaDelle soils, which are on high bottom lands and low terraces, are deep, dark colored, and moderately well drained. They

have a medium-textured to moderately fine textured surface layer. Lamoure soils, which formed in silty alluvium, are poorly drained. They have a seasonally high water table and are susceptible to flooding. Ludden soils, which occur in lower positions on bottom lands than LaDelle soils, are deep, dark colored, and fine textured. They are poorly drained and are occasionally flooded. Ryan soils are dark colored and fine textured. They have a thin surface layer and a subsoil that contains a very slowly permeable claypan. The lower part of the subsoil generally contains a high concentration of salts.

Other soils in this association are mainly of the LaPrairie, Renshaw, Colvin, Eckman, and Buse series. LaPrairie soils, which occur on bottom lands, are deep, dark colored, and medium textured. They are moderately well drained. Renshaw soils are on high terraces. They are underlain by coarse sand and gravel and are well drained. Colvin soils are poorly drained and calcareous. They occur in shallow depressions and seepage areas. Eckman soils, which occur on lower side slopes in the James River Valley, are deep and well drained. They are medium textured. Buse soils are thin and excessively drained. They occur on steep upper slopes.

This association is farmed extensively, but wetness and salinity restrict the use of some areas for crops. LaDelle soils, the most productive in the association, are used mainly for small grain, corn, flax, and alfalfa. Most areas of Lamoure soils are too wet for cultivation. They are used mainly for hay and pasture. About half the acreage of Ludden and Ryan soils is cultivated. Small grain is the main crop. Ryan soils are less suitable for crops than Ludden soils, because the subsoil is saline.

Most farms in this association are diversified. Production of grain and raising of livestock are the main enterprises.

13. Hecla-Maddock association

Nearly level to sloping, moderately well drained to somewhat excessively drained, moderately coarse textured and coarse textured soils on uplands and terraces

This association consists of nearly level to sloping, sandy soils on uplands and terraces east of the James River, in the southeastern part of La Moure County. It makes up about 1 percent of the Survey Area.

Hecla soils make up about 45 percent of the association, and Maddock soils about 40 percent. These soils have a moderately coarse textured to coarse textured surface layer and a coarse textured subsoil. Hecla soils are deep, dark colored, level, and moderately well drained. Maddock soils are well drained to somewhat excessively drained. They are generally more sloping than Hecla soils, and their surface layer is not so thick.

Other soils in this association are mainly of the Embden, Egeland, Arvilla, Claire, and Hamar series. Embden and Egeland soils are deep, moderately coarse textured, upland soils. Arvilla and Claire soils are on terraces along the James River. Arvilla soils are well drained and moderately coarse textured. They are underlain by coarse sand and gravel. Claire soils are excessively drained and coarse textured. Hamar soils are in shallow depressions surrounded by Hecla and Maddock soils. They are somewhat poorly drained.

About 75 percent of this association is cultivated. The main crops are small grain, corn, and alfalfa. A fairly large acreage is used for hay and pasture. The farms are mainly of the diversified grain and livestock type.

14. Hecla-Ulen association

Level to gently undulating, moderately well drained and somewhat poorly drained, moderately coarse textured soils on old glacial lake plains

This association consists mainly of sandy soils on lake plains in the southeastern part of Dickey County. It makes up about 6 percent of the Survey Area.

Hecla soils make up about 35 percent of the association, and Ulen soils about 20 percent. Hecla soils are deep, dark colored, and moderately well drained. They have a surface layer of loamy fine sand or fine sandy loam and a subsoil of loamy fine sand. Ulen soils are somewhat poorly drained, calcareous soils that have a seasonally high water table. The texture of their surface layer and subsoil is like that of Hecla soils. Other soils in this association are of the Maddock, Hamar, Letcher, Stirum, and Renshaw series. Maddock soils are sandy and well drained to somewhat excessively drained. Hamar soils are somewhat poorly drained, but they are lime free. Letcher and Stirum soils are moderately wet or wet alkali soils that formed in sandy deposits.

About 60 percent of this association is cultivated. The main crops are small grain, corn, flax, and alfalfa.

15. Gardena-Glyndon-Overly association

Level, moderately well drained and somewhat poorly drained, medium-textured soils in old glacial lakebeds

This association consists of deep, medium-textured soils east of the James River, in Dickey County. It makes up less than 1 percent of the Survey Area.

Gardena soils make up about 30 percent of the association. Glyndon soils make up about 25 percent, and Overly soils about 20 percent. Gardena and Overly soils are deep, dark-colored, moderately well drained soils that have a medium-textured surface layer. The subsoil of Gardena soils is medium textured, but that of Overly soils is moderately fine textured. Glyndon soils are moderately well drained to somewhat poorly drained. They have a layer of accumulated lime near the surface.

Other soils in this association are of the Aberdeen and Exline series. These soils have a claypan that contains soluble salts.

About 80 percent of this association is cultivated. The main crops are small grain, corn, flax, and alfalfa. The major soils are among the most productive in the Survey Area.

Descriptions of the Soils

This section describes the soil series and mapping units of La Moure County and parts of the James River Valley. The approximate acreage and proportionate extent of each mapping unit are given in table 1.

In the pages that follow, a general description of each soil series is given. Each series contains a short description of a typical soil profile and a much more detailed

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Stutsman County	La Moure County	Dickey County	Total	Percent of survey area
	Acres	*Acres*	*Acres*	*Acres*	
Aberdeen silt loam	0	20	283	303	(1)
Aberdeen-Exline complex	96	0	234	330	(1)
Arveson fine sandy loam	0	76	1, 838	1, 914	0. 2
Arveson fine sandy loam, very poorly drained	0	0	651	651	. 1
Arvilla sandy loam, level	161	1, 639	11	1, 811	. 2
Arvilla sandy loam, undulating	158	717	102	977	. 1
Barnes loam, rolling	0	10, 231	415	10, 646	1. 3
Barnes loam, rolling, eroded	0	17, 806	0	17, 806	2. 2
Barnes stony loam	15	490	14	519	. 1
Barnes-Buse loams, rolling	0	4	1, 497	1, 501	. 2
Barnes-Buse loams, hilly	0	9, 159	504	9, 663	1. 2
Barnes-Cresbard loams	0	19, 461	0	19, 461	2. 4
Barnes, Gardena, and Eckman loams, level	0	14, 461	0	14, 461	1. 8
Barnes-Renshaw loams, rolling	0	1, 203	0	1, 203	. 1
Barnes-Svea loams, undulating	0	233, 966	4, 433	238, 399	28. 9
Bearden silt loam	137	301	2, 133	2, 571	. 3
Bearden silt loam, saline	0	0	441	441	. 1
Bearden-Exline complex	0	0	557	557	. 1
Borup silt loam	0	1, 485	694	2, 179	. 3
Borup silt loam, very poorly drained	0	0	138	138	(1)
Buse-Barnes loams, steep	26	15, 012	103	15, 141	1. 8
Cavour complex	0	2, 454	0	2, 454	. 3
Claire sandy loam	0	667	63	730	. 1
Colvin silty clay loam	0	1, 350	1, 282	2, 632	. 3
Colvin soils, saline	0	0	188	188	(1)
Colvin soils, very poorly drained	48	948	761	1, 757	. 2
Cresbard, Barnes, and Cavour loams	0	20, 371	0	20, 371	2. 5
Cresbard and Cavour loams	0	909	14	923	. 1
Divide loam	189	472	5	666	. 1
Eckman loam, level	13	0	430	443	. 1
Eckman loam, gently sloping	1, 462	4, 640	1, 067	7, 169	. 9
Eckman loam, sloping	609	401	255	1, 265	. 2
Edgeley loam, level	0	1, 382	0	1, 382	. 2
Edgeley loam, undulating	0	940	0	940	. 1
Egeland fine sandy loam, sloping	107	73	53	233	(1)
Egeland fine sandy loam, till substratum, level	0	763	0	763	. 1
Egeland fine sandy loam, till substratum, undulating	0	700	0	700	. 1
Egeland loam, till substratum, undulating	0	319	0	319	(1)
Egeland-Embden fine sandy loams, level	57	383	594	1, 034	. 1
Egeland-Embden fine sandy loams, undulating	220	350	195	765	. 1
Embden fine sandy loam	0	0	2, 223	2, 223	. 3
Embden fine sandy loam, silty substratum	0	0	717	717	. 1
Embden-Gardena loams, till substratum	0	8, 284	0	8, 284	1. 0
Exline silt loam	0	2, 166	1, 217	3, 383	. 4
Exline-Lamoure complex	0	3, 581	0	3, 581	. 4
Fargo silty clay	54	683	0	737	. 1
Fargo and Hegne silty clays	0	729	0	729	. 1
Fordville loam, level	1, 029	1, 471	301	2, 801	. 3
Fordville loam, gently sloping	119	243	83	445	. 1
Fresh water marsh	7	1, 560	1, 625	3, 192	. 4
Gardena loam	568	2, 413	2, 259	5, 240	. 6
Gardena loam, gently sloping	0	118	400	518	. 1
Gardena loam, silty substratum	0	0	344	344	(1)
Gardena loam, till substratum	0	1, 818	0	1, 818	. 2
Gardena and Eckman loams, level	0	8, 911	0	8, 911	1. 1
Glyndon silt loam	148	1, 098	4, 246	5, 492	. 7
Glyndon silt loam, gently sloping	19	87	259	365	(1)
Glyndon silt loam, saline	0	0	389	389	(1)
Glyndon silt loam, silty substratum	0	0	311	311	(1)
Grano silty clay	0	3, 113	0	3, 113	. 4
Gravel pits	42	62	64	168	(1)
Great Bend silty clay loam, gently sloping	0	0	149	149	(1)
Great Bend-Barnes complex, level	0	563	0	563	. 1
Great Bend-Barnes complex, undulating	0	518	0	518	. 1
Hamar fine sandy loam	0	399	0	399	(1)
Hamar loamy fine sand	0	0	851	851	. 1
Hamerly loam	0	0	333	333	(1)
Hamerly-Svea loams	0	10, 918	304	11, 222	1. 4
Hecla fine sandy loam	0	172	4, 100	4, 272	. 5
Hecla fine sandy loam, silty substratum	0	0	914	914	. 1

See footnote at end of table.

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TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Stutsman County	La Moure County	Dickey County	Total	Percent of survey area
	Acres	*Acres*	*Acres*	*Acres*	
Hecla loamy fine sand	0	2, 429	3, 215	5, 644	. 7
Hecla loamy fine sand, gently undulating	0	0	2, 355	2, 355	. 3
Hecla loamy fine sand, silty substratum	0		248	248	(1)
Hecla-Hamar complex	0	0	557	557	. 1
Hecla-Hamar loamy fine sands, level	9	0	1, 136	1, 136	. 1
Hecla-Hamar loamy fine sands, gently undulating	0	0	1, 603	1, 603	. 2
Hecla-Ulen complex, level	0	0	420	420	. 1
Hecla-Ulen complex, gently undulating	0	0	1, 545	1, 545	. 2
Hecla-Ulen fine sandy loams	0	0	389	389	(1)
Hegne-Fargo complex, sandy substrata	0	135	0	135	(1)
LaDelle silt loam	174	2, 206	167	2, 547	. 3
LaDelle silty clay loam	172	868	37	1, 077	. 1
LaDelle soils, clayey substratum	0	867	0	867	. 1
Lamoure silty clay loam	44	5, 239	2, 350	7, 633	. 9
Lamoure silty clay loam, saline	0	166	157	323	(1)
LaPrairie silt loam	1, 683	3, 193	51	4, 927	. 6
LaPrairie silt loam, channeled	1, 460	1, 946	64	3, 470	. 4
LaPrairie and Lamoure soils, channeled	0	5, 798	0	5, 798	. 7
Letcher fine sandy loam	0	0	914	914	. 1
Loamy lake beaches	0	1, 183	0	1, 183	. 1
Ludden silty clay	4	1, 105	2, 494	3, 603	. 4
Ludden silty clay, saline	0	0	244	244	(1)
Ludden-Ryan silty clays	0	771	620	1, 391	. 2
Maddock fine sandy loam, level	0	80	1, 120	1, 200	. 1
Maddock fine sandy loam, undulating	12	389	121	522	. 1
Maddock and Barnes soils, rolling	0	29	93	122	(1)
Maddock and Hecla fine sands, undulating	0	0	361	361	(1)
Maddock and Hecla loamy fine sands, undulating	16	456	0	472	. 1
Maddock and Hecla soils, severely eroded	0	135	683	818	. 1
Maddock-Hecla loamy fine sands, gently undulating	0	0	382	382	(1)
Nutley silty clay, level	0	3, 460	0	3, 460	. 4
Nutley silty clay, gently sloping	0	306	0	306	(1)
Nutley and Fargo silty clays	0	937	0	937	. 1
Overly silt loam	0	2, 282	1, 665	3, 947	. 5
Overly-Aberdeen complex	0	1, 988	0	1, 988	. 2
Parnell silty clay loam	0	27, 780	52	27, 832	3. 4
Peat and muck, shallow	0	0	33	33	(1)
Perella loam	0	0	223	233	(1)
Rauville soils	475	2, 438	283	3, 196	. 4
Rauville soils, sloping	68	79	64	211	(1)
Renshaw loam, level	897	10, 812	2, 779	14, 488	1. 8
Renshaw loam, gently sloping	416	2, 717	380	3, 513	. 4
Renshaw and Sioux soils, level	235	652	0	887	. 1
Renshaw and Sioux soils, gently sloping	147	1, 323	3	1, 473	. 2
Ryan silty clay	0	0	389	389	(1)
Ryan-Ludden silty clays	0	1, 076	786	1, 862	. 2
Saline land	0	549	0	549	. 1
Sioux soils	247	1, 827	156	2, 230	. 3
Spottswood loam	3	148	49	200	(1)
Stirum fine sandy loam	0	0	3, 641	3, 641	. 4
Stirum fine sandy loam, very poorly drained	0	0	343	343	(1)
Stirum-Exline complex	0	0	175	175	(1)
Stirum-Letcher fine sandy loams	0	0	594	594	. 1
Svea loam	0	0	516	516	. 1
Svea-Barnes loams	0	196, 259	1, 508	197, 767	24. 0
Tiffany fine sandy loam	0	0	252	252	(1)
Tiffany fine sandy loam, silty substratum	0	0	281	281	(1)
Tiffany loam	0	756	35	791	. 1
Tonka soils	0	0	675	675	. 1
Tonka and Parnell soils	0	29, 919	0	29, 919	3. 6
Ulen fine sandy loam	0	0	6, 792	6, 792	. 8
Ulen fine sandy loam, silty substratum	0	0	593	593	. 1
Ulen-Hamar complex	0	0	655	655	. 1
Vallers silty clay loam	0	2, 299	0	2, 299	. 3
Venlo fine sandy loam	0	231	0	231	(1)
Water	336	787	445	1, 568	. 2
Total	11, 673	727, 680	84, 737	824, 090	99. 5

[1] Less than 0.05 percent.

description of the same profile that scientists, engineers, and others can use in making highly technical interpretations. Following the profile is a brief statement of the range in characteristics of the soils in the series, as mapped in this Survey Area. The color given in the nontechnical descriptions is for a dry soil. The consistence described is that of a moist soil, because, generally, the layers beneath the surface are moist during nearly all of the growing season. Following the series description, each mapping unit in the series is described individually. For full information on any one mapping unit, it is necessary to read the description of the soil series as well as the description of the mapping unit. Miscellaneous land types, such as Gravel pits, are described in alphabetic order, along with the other mapping units.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. At the end of the description of each mapping unit are listed the capability unit, the range site, and the windbreak site in which the mapping unit has been placed. The pages where these interpretive groups are described can be readily learned by referring to the "Guide to Mapping Units." Many of the terms used in the soil descriptions and other parts of the survey are defined in the Glossary.

Aberdeen Series

The Aberdeen series consists of moderately well drained to somewhat poorly drained soils that have a claypan. These soils formed in medium-textured to moderately fine textured deposits left by glacial melt water. They occur as nearly level to slightly depressed areas on lake plains, stream terraces, and lower foot slopes in the James River Valley.

In a typical profile the surface layer, about 9 inches thick, consists of dark-gray silt loam that is slightly acid. This is underlain by a layer, about 1 inch thick, of light-gray loam. The subsoil, about 11 inches thick, consists of silty clay loam. The upper part consists of dark grayish-brown, firm silty clay loam that has strong, medium, prismatic structure breaking to strong, coarse and medium, blocky. It is slightly acid. The lower part, about 6 inches thick, consists of olive, firm silty clay loam that has moderate, medium, prismatic structure breaking to moderate, medium, blocky. It is mildly alkaline. The underlying material consists of pale-yellow, mottled silt loam that contains segregations of lime and gypsum.

Permeability is moderate in the surface and subsurface layers and slow in the subsoil. The dense subsoil and the salts in the upper part of the substratum limit root penetration. A perched water table occurs just above the subsoil during periods of heavy rainfall. The water table is high in spring, and tillage is often delayed because of wetness.

Most of the acreage is cultivated, but some small areas are used for hay and pasture. If adequately drained and fertilized, these soils are suited to all the crops commonly grown in the Area. Small grain, corn, flax, and alfalfa are the main crops.

Typical profile of Aberdeen silt loam in a cultivated field, 520 feet south and 170 feet west of the NE. corner of sec. 24, T. 130 N., R. 60 W.

Ap—0 to 9 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, medium, granular and blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; slightly acid; abundant roots; abrupt, smooth boundary; sodium adsorption ratio 0.7. 5 to 15 inches thick.

A2—9 to 10 inches, light-gray (10YR 7/1) loam, gray (10YR 5/1) when moist: weak, very thin, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; clear, broken boundary. 0 to 2 inches thick.

B21—10 to 15 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; thin, continuous clay films, dark gray (10YR 4/1), very dark brown (10YR 2/2) when moist; strong, medium, prismatic structure breaking to strong, coarse and medium, blocky; hard when dry, firm when moist, sticky and plastic when wet; slightly acid; abundant roots; bleached sand grains on vertical faces; gradual boundary; sodium adsorption ratio 0.9. 4 to 8 inches thick.

B22—15 to 21 inches, olive (5Y 5/3) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; hard when dry, firm when moist, sticky and plastic when wet; mildly alkaline; few roots; clear, wavy boundary; sodium adsorption ratio 0.6. 4 to 8 inches thick.

Cca—21 to 36 inches, pale-yellow (5Y 7/3) silt loam, olive (5Y 5/3) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline; few roots; strongly calcareous; segregations of lime and gypsum; gradual boundary; sodium adsorption ratio 4.2.

C—36 to 60 inches, pale-yellow (2.5Y 8/4) silt loam, light olive brown (2.5Y 5/4) when moist; common, medium, brownish-yellow (10YR 6/6) mottles; hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline; strongly calcareous; segregations of lime and gypsum; sodium adsorption ratio 8.9.

In some places cultivation has brought material from the subsurface layers to the surface. The structure of the subsoil material is typically moderate to strong blocky, but in some places this material has columnar structure. The texture of the underlying material ranges from silt loam to silty clay loam. In some places thin layers of sand occur at a depth below 36 inches.

Aberdeen soils have a thicker surface layer than Exline soils, and the structure of their subsoil is medium to strong blocky, rather than strong columnar. They are finer textured than Stirum and Letcher soils. Aberdeen soils developed in deposits left by glacial melt water rather than in glacial till, which was the parent material of Cresbard and Cavour soils. They have a gray, platy subsurface layer, which is lacking in Overly and Great Bend soils.

Aberdeen silt loam (0 to 5 percent slopes) (Ab).—This soil occurs on foot slopes and terraces in the James River Valley and on lake plains. It is moderately deep to a claypan. About 75 percent of the acreage is level, and about 25 percent is gently sloping. Included in mapping were areas, generally less than 2 acres in size, of Overly and Great Bend soils.

This soil has the profile described as typical of the series. The surface layer is 7 to 11 inches thick in level areas and 5 to 8 inches thick in sloping areas. In some places cultivation has brought material from the subsurface layer into the surface layer. The root zone is shallow, and the claypan subsoil restricts roots and penetration of moisture.

Most of the acreage is cultivated, but a small part is used for hay. Small grain, flax, corn, and alfalfa are

fairly well suited. The soil is occasionally flooded in years when rainfall is above normal, and surface drainage is needed to remove excess water. Trees are poorly suited. (Capability unit IIIs-6P; Silty range site; windbreak site 8)

Aberdeen-Exline complex (0 to 2 percent slopes) (Ae).—This complex consists of claypan soils on lower slopes, terraces, and bottom lands in the James River Valley. The Exline soil occurs in small, shallow depressions, and the Aberdeen soil, in slightly higher positions. Included in mapping were small areas of LaPrairie silt loam and Overly silt loam.

Aberdeen silt loam makes up about 60 to 80 percent of the complex. The surface layer is 5 to 8 inches thick, and in some places it has been mixed with gray material from the subsurface layer. The Exline soil has a thin surface layer and a strongly developed subsoil that has columnar structure. Crystals of soluble salts and gypsum occur high in the profile.

Most of the acreage is cultivated, but salinity affects productivity. Tillage generally brings material from the upper part of the claypan into the surface layer of the Exline soil. Cultivated areas of this soil are hard and cloddy when dry and sticky when wet. In many years spring tillage must be delayed because of wetness.

This complex is suited to salt-tolerant crops. It is poorly suited to windbreaks. (Capability unit IIIs-6P; Saline Subirrigated range site; windbreak site 8)

Arveson Series

The Arveson series consists of poorly drained and very poorly drained, calcareous soils on sandy uplands. These soils formed in moderately coarse textured and coarse textured deposits left by glacial melt water.

In a typical profile the surface layer, about 10 inches thick, consists of dark-gray and gray fine sandy loam that is calcareous to strongly calcareous. The next layer, about 12 inches thick, consists of light-gray, strongly calcareous loamy fine sand that has weak, coarse, prismatic structure breaking to single grain. Below this is light-gray fine sandy loam and light-gray and greenish-gray loamy fine sand.

Permeability is moderately rapid. The water table is at or near the surface in spring and during periods of heavy rainfall; it is within 3 feet of the surface during most of the growing season.

Most areas of Arveson soils are used for pasture and hay. Small areas are farmed along with adjoining soils, but cultivation is often delayed because of wetness. Drained areas are suitable for cultivation, but wind erosion is a hazard.

Typical profile of Arveson fine sandy loam in an area of native grasses, 1,300 feet south and 130 feet west of the center of sec. 34, T. 130 N., R. 59 W.

A1—0 to 2 inches, dark-gray (N 4/0) fine sandy loam, black (10YR 2/1) when moist; weak, medium, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; abrupt, smooth boundary; sodium adsorption ratio 8.4.

A12ca—2 to 10 inches, dark-gray and gray (5Y 4/1 and 5/1) fine sandy loam, very dark gray and dark olive gray (5Y 3/1 and 3/2) when moist; moderate, medium, blocky and granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual, smooth boundary; sodium adsorption ratio 7.3.

C1ca—10 to 22 inches, light-gray (5Y 7/1) loamy fine sand, light olive gray (5Y 6/2) when moist; weak, coarse, prismatic structure breaking to single grain; soft when dry, loose when moist, nonsticky and nonplastic when wet; strongly calcareous; clear, smooth boundary; sodium adsorption ratio 6.6.

C2g—22 to 30 inches, light-gray (5Y 7/1) fine sandy loam, olive gray (5Y 5/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/4, dry) mottles; structureless; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; clear, smooth boundary; sodium adsorption ratio 4.1.

C3g—30 to 46 inches, light-gray (5Y 7/1) loamy fine sand, olive gray (5Y 5/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/4, dry) mottles; soft when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; abrupt, smooth boundary; sodium adsorption ratio 4.3.

C4g—46 to 60 inches, greenish-gray (5GY 6/1) loamy fine sand, olive gray (5Y 4/2) when moist; soft when dry, very friable when moist, nonsticky and nonplastic when wet; sodium adsorption ratio 2.2.

The surface layer ranges from fine sandy loam to loam in texture, and from 6 to 14 inches in thickness. The strongly calcareous layer in the substratum ranges from light olive gray to gray in color, and from loamy fine sand to fine sandy loam in texture. It ranges from 6 to 14 inches in thickness. In some places on lake plains, thin layers of silt loam or silty clay loam occur below a depth of 4 feet; in other places, glacial till occurs below a depth of 30 inches.

Arveson soils have a concentration of lime just below the surface layer, which is lacking in Hecla, Hamar, Venlo, Embden, and Tiffany soils. They have a larger number of distinct mottles in their substratum than Ulen and Glyndon soils. Arveson soils developed in coarser textured material than Borup and Glyndon soils.

Arveson fine sandy loam (0 to 2 percent slopes (Af).—This soil occurs in nearly level, shallow depressions on sandy lake plains and on sandy uplands. In most places it is surrounded by slightly higher areas of Hecla and Maddock soils. Included in mapping were small areas of Hamar fine sandy loam and Arveson fine sandy loam, very poorly drained. Also included were a few small areas where the surface layer is loam.

This soil has the profile described as typical of the series. The water table is at or near the surface in spring and during periods of heavy rainfall and is within 3 feet of the surface during most of the growing season.

Most of the acreage is used for hay and pasture. The vegetation is mainly big bluestem, switchgrass, and lowland sedges. Some areas are farmed along with adjoining soils. In cultivated areas, the chief management problem is control of wetness. Wind erosion is a hazard when the surface is dry. (Capability unit IIIwe-3; Subirrigated range site; windbreak site 7)

Arveson fine sandy loam, very poorly drained (0 to 2 percent slopes) (An).—This soil is in shallow depressions, surrounded by higher lying Hecla and Maddock soils. The water table is at or near the surface throughout most of the growing season. Included in mapping were small areas of poorly drained Arveson soils and small areas where the surface layer is loam.

This soil is used for hay and pasture. Drained areas are suitable for cultivation, but drainage is not generally feasible, because outlets are available in only a few areas.

The vegetation consists mainly of slough grasses, sedges, and rushes. (Capability unit Vw–WL; Wetlands range site; windbreak site 7)

Arvilla Series

The Arvilla series consists of well-drained, nearly level to sloping soils on terraces in the James River Valley. These soils formed in moderately coarse textured glacial outwash overlying coarse sand and gravel.

In a typical profile the surface layer consists of very dark gray sandy loam about 7 inches thick. The subsoil, about 7 inches thick, consists of dark grayish-brown, friable sandy loam that has moderate, coarse and medium, prismatic structure. The underlying material is slightly calcareous, grayish-brown to brown very coarse sand and coarse sand. The lower part contains a few fragments of shale.

Permeability is rapid in the surface layer and subsoil and very rapid in the substratum. These soils are droughty, and they have low moisture-holding capacity.

Nearly level areas of these soils are cultivated. The principal crops are small grain, corn, and alfalfa. The sloping areas are used mainly for hay and pasture. The principal native grasses are needle-and-thread and blue grama. Nearly all cultivated areas have been slightly to moderately eroded by wind. The subsoil is exposed in some areas.

Typical profile of an Arvilla sandy loam in a cultivated field, 180 feet south and 220 feet east of the NW. corner of the SW¼ of sec. 22, T. 133 N., R. 60 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) sandy loam, black (10YR 2/1) when moist; weak, fine, blocky and granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; abrupt, smooth boundary; a few tongues of this layer extend to a depth of 10 inches.

B—7 to 16 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse and medium, prismatic structure breaking to moderate, medium, blocky; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary.

IIC1—16 to 28 inches, grayish-brown to brown (10YR 5/2 and 5/3) very coarse sand, brown to dark brown (10YR 4/3 to 3/3) when moist; loose when dry, loose when moist, nonsticky and nonplastic when wet; very few roots; slightly calcareous; gradual, wavy boundary.

IIC2—28 to 56 inches, grayish-brown to brown (10YR 5/2 to 5/3) coarse sand, brown to dark brown (10YR 4/3 to 3/3) when moist; loose when dry or moist, nonsticky and nonplastic when wet; a few shale fragments; very few roots in upper 6 inches; slightly calcareous.

The material above the coarse sand ranges from 14 to 22 inches in thickness. The colors of the surface layer include very dark brown and very dark gray. The surface layer ranges from 4 to 12 inches in thickness, and the subsoil ranges from 5 to 10 inches in thickness. In some profiles the ped faces in the subsoil have organic stains. The structure of the substratum ranges from coarse sand to gravel. In some places there is a thin layer of loamy sand above the coarser material.

Arvilla soils have a thicker solum than Sioux soils. They developed in coarser textured material than Renshaw and Fordville soils. They lack the accumulation of lime that is typical of Divide soils. Arvilla soils have a finer textured subsoil and are shallower to coarse sand than Claire soils. The underlying coarse sand and gravel distinguishes Arvilla soils from Egeland soils.

Arvilla sandy loam, level (0 to 2 percent slopes) (ArA).—This soil occurs on terraces in the James River Valley. Included in mapping were areas of moderately deep Arvilla sandy loam, which make up about 15 percent of the acreage. Also included were areas, less than 2 acres in size, of Sioux soils and of Claire sandy loam.

This soil has the profile described as typical of the series. It is droughty and is susceptible to wind erosion. In small areas the soil is eroded and the subsoil is exposed.

Most of the acreage is cultivated, but some is used for hay and pasture. Small grain, corn, and alfalfa are the main crops. Trees are fairly well suited. (Capability unit IIIes–3; Sandy range site; windbreak site 5)

Arvilla sandy loam, undulating (3 to 6 percent slopes) (ArB).—This soil is on terraces in the James River Valley. In about 10 percent of the acreage the slope is 6 to 12 percent. Included in mapping were areas of moderately deep Arvilla sandy loam, gently sloping, which make up about 20 percent of the acreage. Also included were small areas of Sioux soils and of Claire sandy loam.

This soil has a profile like that described as typical of the series. In small areas the soil is eroded and the subsoil is exposed. This soil is droughty because of the underlying sand and gravel, and it is susceptible to wind erosion when cultivated.

Most of the acreage is used for hay and pasture, but some areas are cultivated. Small grain, corn, and alfalfa are the main crops. Trees are fairly well suited. (Capability unit IIIes–3; Sandy range site; windbreak site 5)

Barnes Series

The Barnes series consists of deep, well-drained soils in nearly level to hilly areas on glaciated uplands throughout La Moure County and on side slopes in the James River Valley. These soils formed in medium-textured to moderately fine textured glacial till.

In a typical profile (fig. 2) the surface layer, about 8 inches thick, consists of dark-gray, noncalcareous loam. The subsoil, about 12 inches thick, consists of brown, friable loam that has weak, medium and coarse, prismatic structure breaking to moderate, medium, subangular blocky. It is noncalcareous. The underlying material consists of light yellowish-brown to light brownish-gray loam. The upper part is very strongly calcareous and contains many concretions of lime. The lower part is mottled, is strongly calcareous, and contains a few concretions of lime.

Permeability is moderate, and the moisture-holding capacity is high. Runoff is medium in level areas but rapid on hilly slopes. These soils are well supplied with organic matter and plant nutrients.

Most of the nearly level and undulating areas are cultivated. Small grain, flax, corn, alfalfa, and tame grasses are well suited. Most of the rolling and hilly areas are used for pasture.

Typical profile of a Barnes loam, 130 feet east and 220 feet south of the NW. corner of sec. 7, T. 133 N., R. 62 W.

Ap—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

Figure 2.—**Profile of Barnes loam. This is a deep, dark-colored, well-drained soil that formed in glacial till.**

B2—8 to 20 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; weak, medium and coarse, prismatic structure breaking to moderate, medium, subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, wavy boundary.

C1ca—20 to 36 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; many lime concretions; gradual, wavy boundary.

C2—36 to 60 inches, light brownish-gray (2.5Y 6/2) loam, olive brown (2.5Y 4/4) when moist; few, fine, distinct mottles of light olive brown (2.5Y 5/6, moist); slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; few lime concretions.

The surface layer is 4 to 10 inches thick. It has loam, silt loam, or clay loam texture and blocky or granular structure. The subsoil is 4 to 14 inches thick. The color ranges from brown to dark brown to very dark grayish brown, and the texture from loam to clay loam. The texture of the underlying material ranges from loam to clay loam. Gypsum crystals occur in some places.

Barnes soils have a thinner surface layer than Svea soils. They have a B horizon, which is lacking in Buse soils. Barnes soils lack the accumulation of lime just below the surface layer that Hamerly soils have. They formed in glacial till, rather than in melt-water deposits, which was the parent material of Eckman soils.

Barnes loam, rolling (6 to 9 percent slopes) (BaC).—This soil is on glaciated uplands and valley side slopes in La Moure and Dickey Counties. Included in mapping were small areas of Svea loam on the lower slopes and of Buse loam on hilltops.

The profile of this soil is like that described as typical of the series, except that the surface layer is not so thick.

This soil is suitable for cultivation, but it is highly susceptible to water erosion because runoff is rapid. Small grain, flax, and alfalfa are better suited than other crops. Corn is not generally grown, because of the erosion hazard. Management practices that help control water erosion are stubble-mulch tillage and management of crop residue. In most places contour stripcropping is not practical, because of the short, irregular slopes. About half the acreage is in native pasture and hay. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIe–6; Silty range site; windbreak site 6)

Barnes loam, rolling, eroded (6 to 9 percent slopes) (BaC2).—This soil occurs mainly on glaciated uplands in the western part of La Moure County and on valley side slopes. Included in mapping were small areas of Svea loam on the lower slopes and of Buse loam on the higher knolls.

This soil has a profile like that described as typical of the series, except that the surface layer is not so thick. The brownish subsoil and the light-gray underlying material have been exposed, mainly by water erosion, in places.

Nearly all the acreage is used for crops. Small grain, flax, and alfalfa are suitable. Corn is not generally grown, because of the erosion hazard. This soil is highly susceptible to water erosion. Management practices that help control erosion are stubble-mulch tillage and use of crop residue. Contour stripcropping generally is not practical, because of the short, irregular slopes. The organic-matter content is low, and grasses and legumes should be included frequently in the cropping system. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIe–6; Silty range site; windbreak site 6)

Barnes stony loam (4 to 9 percent slopes) (Be).—This soil is on glaciated uplands in La Moure County and on side slopes and terraces in the James River Valley. The underlying material is mainly glacial till, but in some places it is coarse sand and gravel. In places the slope is as much as 15 percent, and in a few areas the surface layer is sandy loam.

This soil is too stony for cultivation, and all the acreage is in native grass. Most areas are used for pasture. The stones interfere with haying. Trees are not suited. (Capability unit VIs–Si; Silty range site; windbreak site 8)

Barnes-Buse loams, rolling (6 to 12 percent slopes) (BbC).—This complex consists of well-drained to excessively drained soils on glaciated uplands and side slopes in the James River Valley. Barnes loam makes up about 65 percent of the complex, and Buse loam about 35 percent. The Buse soil is on hilltops and upper slopes, and the Barnes soil is on lower slopes. Included in mapping were small areas of Svea loam, a Tonka silt loam, an Eckman loam, and areas where the slope is 3 to 5 percent.

The Barnes soil has a profile like that described as typical of the series, except that the surface layer is not so thick.

These soils are susceptible to water erosion because runoff is rapid. The organic-matter content and the supply of

plant nutrients are somewhat low. The moisture-holding capacity is high.

This complex is suitable for cultivated crops, such as small grain, flax, and alfalfa. Corn is not generally grown, because of the erosion hazard. Management practices that help control erosion are stubble-mulch tillage, use of crop residue, frequent inclusion of grasses and legumes in the cropping system, and fertilizing. These practices also help to maintain organic-matter content and fertility. Contour stripcropping generally is not practical, because of the short, irregular slopes. Some areas are used for native pasture. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIe-6; Silty range site; windbreak site 6)

Barnes-Buse loams, hilly (9 to 15 percent slopes) (BbD).—This complex consists of excessively drained soils, mainly on hilly uplands in the western part of La Moure County and of scattered areas on valley side slopes. Barnes loam makes up about 60 percent of the complex, Buse loam about 35 percent, and Svea loam about 5 percent. The Buse soil is on hilltops and upper slopes, the Barnes soil is on the milder upper slopes, and the Svea soil is on lower foot slopes.

The Barnes soil has a profile like that described as typical of the series, except that the surface layer is not so thick and accumulated lime is nearer the surface. In cultivated fields the thin surface layer of the Buse soil has been mixed with the subsoil in many places, and the surface has a light-gray color.

Surface runoff is rapid. Cultivated areas are highly susceptible to water erosion unless they are protected. Most of this complex is used for native pasture and hay, but some is used for small grain, alfalfa, and tame grasses. Corn is seldom grown, because of the erosion hazard. Management practices that help to control water erosion are stubble-mulch tillage, use of crop residue, and inclusion of grass and legumes in the cropping system about half the time. Trees for farmstead windbreaks are fairly well suited. (Capability unit IVe-6; Silty range site; windbreak site 6)

Barnes-Cresbard loams (0 to 3 percent slopes) (Bc).—This complex consists of well drained and moderately well drained soils on uplands. It occurs mainly south and west of Edgeley. Barnes loam makes up about 75 percent of the complex, and Cresbard loam about 15 percent. The rest consists of small areas of Svea loam and a Tonka silt loam.

The Barnes soil, which occurs in slightly higher positions than the Cresbard soil, is deep and well drained. It has high moisture-holding capacity and is moderately permeable. The Cresbard soil is moderately well drained and is somewhat droughty. It has a thick, medium-textured surface layer and a subsoil that contains a slowly permeable claypan.

This complex is well suited to cultivated crops, such as wheat, oats, barley, rye, flax, corn, and alfalfa. Conservation of moisture and maintenance of fertility and tilth are the main problems. Stubble-mulch tillage, management of crop residue, and fertilizing help to conserve moisture and maintain organic-matter content and fertility. Frequent inclusion of legumes and grasses in the cropping system helps to improve permeability of the Cresbard soil. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc-6; Silty range site; windbreak site 2)

Barnes, Gardena, and Eckman loams, level (0 to 3 percent slopes) (BgA).—This undifferentiated unit consists of deep, medium-textured soils on uplands, mainly in the east-central part of La Moure County. Barnes loam makes up about 50 percent of the acreage, and Gardena loam and Eckman loam make up the rest. Included in mapping were small areas of Svea loam and a Tonka silt loam.

These soils have profiles like those described as typical of their respective series, except that in many places the Gardena and Eckman soils are underlain by glacial till at a depth of about 3 feet. They are well supplied with organic matter and plant nutrients, and they have high moisture-holding capacity.

Most of this complex is cultivated. Wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Conservation of moisture and maintenance of fertility are the main management problems. Erosion is not a problem. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help conserve moisture and maintain fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc-6; Silty range site; windbreak site 2)

Barnes-Renshaw loams, rolling (4 to 9 percent slopes) (BhC).—This complex occurs on undulating to rolling uplands in La Moure County. Barnes loam makes up about 60 percent of the complex, Renshaw loam about 35 percent, and Svea loam about 5 percent. Included in mapping were small areas of a Sioux loam.

The Barnes loam has high moisture-holding capacity. The Renshaw loam is droughty because of the underlying sand and gravel.

This complex is used mainly for crops, such as small grain, flax, corn, and alfalfa. Some areas are used for native pasture. Control of erosion and conservation of moisture are the main management problems. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing are practices that help to control erosion, conserve moisture, and maintain fertility. Trees are fairly well suited. (Capability unit IIIe-6; Silty range site; windbreak site 6)

Barnes-Svea loams, undulating (3 to 6 percent slopes) (BnB).—This complex consists of deep, medium-textured, well drained and moderately well drained soils on undulating uplands. Barnes loam makes up about 65 percent of the complex, and Svea loam about 35 percent. The Barnes soil occupies the higher positions on the landscape. Included in mapping were small areas of poorly drained Tonka and Parnell soils in depressions and Hamerly soils in narrow bands around the depressions.

These soils are resistant to wind erosion, but they are moderately susceptible to water erosion. They are well supplied with organic matter and plant nutrients, and they have high moisture-holding capacity.

Most of this complex is cultivated. Wheat, oats, barley, rye, flax, corn, and alfalfa are well suited. The chief management problems are control of erosion, conservation of moisture, and maintenance of organic-matter content and fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help control erosion, conserve moisture, and maintain fertility. Trees for field and farmstead wind-

breaks are well suited. (Capability unit IIe–6; Silty range site; Barnes part is in windbreak site 2; Svea part is in windbreak site 1)

Bearden Series

The Bearden series consists of somewhat poorly drained calcareous soils on lake plains and on foot slopes and terraces in the James River Valley. These soils occur as nearly level to slightly depressed areas. They formed in medium-textured to moderately fine textured lake sediments and melt-water deposits.

In a typical profile the surface layer, about 8 inches thick, consists of very dark gray silt loam that is slightly calcareous. The next layer is very dark gray silt loam about 5 inches thick. The upper part of the underlying material consists of light-gray to gray, friable, very strongly calcareous silty clay loam. The lower part consists of slightly calcareous to strongly calcareous, pale-yellow to white, mottled silty clay loam. Pockets of gypsum crystals are common below a depth of 20 inches.

Permeability is moderate in the surface layer but moderately slow in the underlying material. The moisture-holding capacity is high. The water table is within 5 feet of the surface during most of the year but near the surface in spring.

Most of the acreage is used for crops, such as small grain, corn, flax, and alfalfa. Some areas that are affected by salinity or wetness are used for hay and pasture.

Typical profile of Bearden silt loam in a cultivated field, 80 feet west and 0.17 mile north of the SE. corner of sec. 27, T. 129 N., R. 59 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; moderate, medium, blocky and granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; slightly calcareous; abrupt, smooth boundary; sodium adsorption ratio 0.5.

A1—8 to 13 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; few, fine, prominent lime segregations; slightly calcareous; clear, wavy boundary; sodium adsorption ratio 0.9.

C1ca—13 to 28 inches, light-gray to gray (5Y 6/1) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, sticky and plastic when wet; plentiful roots; common pockets of gypsum crystals below a depth of 20 inches; very strongly calcareous; clear, wavy boundary; sodium adsorption ratio 7.3.

C2ca—28 to 36 inches, mottled, pale-yellow (2.5Y 7/4 and 5Y 7/3) silty clay loam, light olive brown and olive (2.5Y 5/4 and 5Y 5/4) when moist; weak, medium, prismatic structure breaking to moderate, medium, blocky; hard when dry, friable when moist, sticky and plastic when wet; few roots; many, moderate, distinct lime segregations and common pockets of gypsum crystals; strongly calcareous; clear, wavy boundary; sodium adsorption ratio 15.0.

C3—36 to 48 inches, mottled, pale-yellow (2.5Y 8/4 and 7/3), light-gray, and white (5Y 8/1) silty clay loam, light olive brown (2.5Y 5/4) and light olive gray (5Y 6/2) when moist; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous to strongly calcareous; clear, wavy boundary; sodium adsorption ratio 18.4.

C4—48 to 60 inches, mottled, pale-yellow (5Y 7/4) and white (N 8/0) silty clay loam, olive (5Y 5/4) and light gray to gray (N 7/0) and N 6/0) when moist; hard when dry, firm when moist, sticky and plastic when wet; common pockets of gypsum crystals; slightly calcareous to strongly calcareous; sodium adsorption ratio 19.0.

The surface layer ranges from 8 to 15 inches in thickness and from silt loam to silty clay loam in texture. The underlying material ranges from silt loam to silty clay loam. Medium and coarse sand occurs at a depth below 3 feet in some places. Stratified fine sandy loam to clay occurs at a depth below 3 feet on low foot slopes in the James River Valley.

Bearden soils developed in finer textured sediments than Glyndon and Borup soils, but in coarser textured sediments than Hegne and Fargo soils. They lack the noncalcareous to slightly calcareous subsoil of Overly and Gardena soils. They are better drained and less mottled than Colvin soils.

Bearden silt loam (0 to 2 percent slopes) (Bo).—This soil occurs on lake plains and on lower foot slopes and bottom lands in the James River Valley. Included in mapping were areas of silty clay loam, which make up as much as 20 percent of the acreage. Also included were areas, less than 2 acres in size, of Overly, Colvin, and Glyndon soils.

This soil has the profile described as typical of the series.

This soil is moderately to highly susceptible to wind erosion because the limy material is granular. In some areas tillage has brought limy material into the surface layer, and there are many light-gray spots in cultivated fields. The water table is seasonally high. Wetness delays tillage in years when spring rainfall is heavy.

Most of the acreage is used for crops, such as small grain, flax, corn, alfalfa, and tame grasses. Some of the wetter areas are used for hay and pasture. Trees are well suited. (Capability unit IIe–4L; Silty range site; windbreak site 1)

Bearden silt loam, saline (0 to 2 percent slopes) (Br).—This soil is on lake plains. Included in mapping were areas of silty clay loam, which make up about 5 percent of the acreage. Also included were areas, less than 2 acres in size, of Colvin and Glyndon soils, which contain a large amount of soluble salts in the surface layer and subsoil.

This soil has a profile like that described as typical of the series, except that the surface layer and the upper part of the underlying material contain enough soluble salts to affect plant growth.

Most of the acreage is used for hay and pasture, but some areas are cultivated. Salt-tolerant crops, such as barley, rye, oats, wheat, sudangrass, and millet, are suitable. Frequent inclusion of sweetclover and alfalfa in the cropping system helps to lower the water table and reduce the salt content. Trees are poorly suited, but some are grown for farmstead windbreaks. (Capability unit IIIs–4; Saline Subirrigated range site, windbreak site 8)

Bearden-Exline complex (0 to 2 percent slopes) (Bs).—This complex occurs on lake plains. The Bearden soil occupies slightly higher positions than the Exline soil. Included in mapping were areas, less than 2 acres in size, of Glyndon and Colvin soils.

Bearden silt loam makes up about 70 percent of the complex. It has a profile like that described as typical of the series, except that in some areas the surface layer and the upper part of the underlying material contain soluble

salts. The Exline soil makes up about 30 percent of the complex. This soil has a thin surface layer and a dense, slowly permeable claypan subsoil that has a high content of soluble salts. The water table is within 3 feet of the surface in spring.

Most of the complex is cultivated. Salt-tolerant crops, such as small grain, barley, rye, oats, and wheat, are suitable. Sweetclover and alfalfa help to improve permeability of the subsoil and lower the water table. In cultivated areas of the Exline soil, tillage has brought material from the subsoil into the surface layer, and the surface is hard and crusty when dry and sticky when wet. Trees are poorly suited. (Capability unit IIIs–6P; Saline Subirrigated range site; windbreak site 8)

Borup Series

The Borup series consists of poorly drained and very poorly drained, calcareous soils. These soils occur as nearly level, slightly depressed areas on lake plains, in outwash channels in the central and eastern parts of La Moure County, and on lower foot slopes below terraces in the James River Valley. They formed in medium-textured lake sediments and in deposits left by glacial melt water.

In a typical profile the surface layer, about 10 inches thick, consists of very dark gray to gray silt loam that is slightly calcareous to strongly calcareous. The next layer, about 14 inches thick, consists of gray silt loam that has weak, medium, subangular blocky structure. It is strongly calcareous. Below this is mottled, light olive-gray, slightly calcareous coarse sandy loam that has weak, coarse, angular blocky structure. The underlying material is grayish-brown, noncalcareous coarse sand and gravel.

Permeability is moderate. The water table is within 3 feet of the surface most of the year and at or near the surface in spring.

Most of the acreage is used for hay and pasture. Drained areas can be used for small grain, flax, corn, and millet, which can be planted late in the season. Undrained areas are usually too wet for cultivation. The high water table and the lack of suitable outlets make drainage difficult.

Typical profile of Borup silt loam in a native pasture, about 80 feet east and 280 feet south of the SW. corner of sec. 4, T. 134 N., R. 64 W.

A1—0 to 5 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure and moderate, medium, crumb structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; clear, smooth boundary.

A12ca—5 to 10 inches, gray (N 5/0) silt loam, very dark gray (10YR 3/1) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual boundary.

C1ca—10 to 24 inches, gray (N 6/0) silt loam, dark gray (5Y 4/1) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual boundary.

C2g—24 to 38 inches, light olive-gray (5Y 6/2) coarse sandy loam, olive gray (5Y 5/2) when moist; many, coarse, prominent, very dark grayish-brown (10YR 3/2, moist) mottles; weak, coarse, angular blocky structure; slightly hard when dry, friable when moist; slightly calcareous; abrupt boundary.

IIC3—38 to 60 inches, grayish-brown (2.5Y 5/2) coarse sand and gravel, light olive brown (2.5Y 5/4) when moist; single grain; loose; noncalcareous.

The surface layer ranges from 6 to 15 inches in thickness. The lower part has an accumulation of lime in places. The next layer ranges from very dark gray to gray in color and from 8 to 18 inches in thickness. In many areas coarse sand and gravel occur below a depth of 36 inches. This material is noncalcareous in some places but is strongly calcareous in others. In places crystals of soluble salts and gypsum occur throughout the profile.

Borup soils developed in coarser textured material than Colvin soils but in finer textured material than Arveson soils. They are more poorly drained than Glyndon soils, and they have more mottles in their substratum than those soils. They lack the noncalcareous subsoil of Tiffany and Perella soils.

Borup silt loam (0 to 2 percent slopes) (Bt).—This soil occurs in outwash channels in the central and eastern parts of La Moure County, on lower foot slopes in the James River Valley, and on lake plains. It is poorly drained. In some small areas the surface layer and subsoil contain soluble salts that have a slight to moderate effect on plant growth. Included in mapping were small areas of Glyndon silt loam, Bearden silt loam, Colvin silty clay loam, and Perella loam.

This soil has the profile described as typical of the series. It is well supplied with organic matter and plant nutrients. The water table rises to within 2 feet of the surface after rapid snowmelt or heavy rains.

Drained areas are well suited to cultivated crops. Small grain, corn, flax, millet, and alfalfa are the main crops. Undrained areas are used mainly for hay and pasture. (Capability unit IIw–4L; Subirrigated range site; windbreak site 8)

Borup silt loam, very poorly drained (0 to 2 percent slopes) (Bu).—This soil is in shallow depressions on lake plains. The water table is at or slightly below the surface throughout most of the growing season.

This soil is suited to hay and pasture. Drained areas are suitable for cultivation, but outlets generally are not available. The native vegetation consists mainly of slough grasses, sedges, and rushes. (Capability unit Vw–WL; Wetlands range site; windbreak site 8)

Buse Series

The Buse series consists of excessively drained, medium-textured soils on hilly uplands in the northwestern part of La Moure County and on steep upper slopes in the James River Valley. These soils formed in glacial till.

In a typical profile the surface layer, about 5 inches thick, consists of very dark gray, noncalcareous loam. The next layer, about 7 inches thick, is light brownish-gray, friable loam that has moderate, medium, prismatic structure. It is strongly calcareous. Below this is light-gray, strongly calcareous, friable loam that has moderate, medium, blocky structure. Light yellowish-brown, strongly calcareous, friable loam begins at a depth of about 18 inches. This material is mottled with olive yellow and yellowish brown.

Permeability is moderate in the surface layer, but it is moderately slow below a depth of about 5 inches. The moisture-holding capacity is high, but the soil is droughty because runoff is rapid.

Buse soils are used mainly for pasture, but the less sloping areas associated with Barnes soils are used for small grain, flax, and alfalfa.

Typical profile of a Buse loam, about 0.5 mile west and 180 feet south of the NE. corner of sec. 9, T. 134 N., R. 65 W.

A1—0 to 5 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, granular and crumb structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

C1—5 to 12 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, prismatic structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual, wavy boundary.

C2ca—12 to 18 inches, light-gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) when moist; moderate, medium, blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; gradual, wavy boundary.

C3—18 to 60 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; few, medium, distinct, olive-yellow (2.5Y 6/8, moist) and yellowish-brown (10YR 5/8, moist) mottles; massive; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

The surface layer ranges from 3 to 6 inches in thickness. It is noncalcareous to slightly calcareous. The next layer has an accumulation of lime in places. This material is strongly calcareous to very strongly calcareous. The underlying material has a zone of lime accumulation in places and is strongly to very strongly calcareous.

Buse soils are closely associated with the well-drained Barnes soils, but they lack a B horizon, which Barnes soils have. Also, they have a zone of accumulated lime nearer the surface than in Barnes soils. The material below the surface layer has less lime than that below the surface layer of Hamerly soils.

Buse-Barnes loams, steep (15 to 30 percent slopes) (BvE).—This complex occurs on hilly uplands, mainly in the northwestern part of La Moure County and on steep upper slopes in the James River Valley (fig. 3). Buse loam makes up about 55 percent of the complex, and Barnes loam about 45 percent. The Buse soil is on hilltops and steep upper slopes, and the Barnes soil occupies the milder slopes. Included in mapping were small areas of Svea loam in draws and on lower slopes and areas of Sioux soils on upper slopes.

The Barnes soil has a profile like that described as typical of the Barnes series, except that the surface layer is thinner and lime is near the surface. Runoff is rapid, and the soils are highly susceptible to water erosion if cultivated.

Most of the complex is used for native pasture. The native vegetation consists mainly of little bluestem, needle-and-thread, plains muhly, side-oats grama, and blue grama. Proper stocking of the range and controlled grazing help to maintain good stands of native grasses. Areas that have been cultivated should be reseeded to grass. (Capability unit VIe–Tsi; Thin Silty range site; windbreak site 8)

Figure 3.—**Landscape of Buse-Barnes loams, steep. This area is on upper slopes in the James River Valley, near Adrian.**

Cavour Series

The Cavour series consists of somewhat poorly drained, saline soils that occur as nearly level areas or slight depressions on till plains in La Moure County. These soils formed in medium-textured to moderately fine textured glacial till.

In a typical profile the surface layer, about 5 inches thick, consists of dark-gray, noncalcareous loam. The subsurface layer, about 1 inch thick, consists of gray, very friable, noncalcareous loam that has moderate, medium, platy structure. The subsoil, about 12 inches thick, is very dark gray, noncalcareous, firm silty clay loam that has strong, coarse, columnar structure in the upper part and moderate, medium, angular blocky structure in the lower part. Salts and gypsum occur in the lower part. The upper part of the underlying material is pale-yellow silt loam that contains lime concretions and is strongly calcareous. The lower part is light yellowish-brown, strongly calcareous loam.

Permeability is very slow. The subsoil restricts roots and penetration of water. The water table is within 5 feet of the surface throughout the year and is at or near the surface in spring.

Most of the acreage is used for hay and pasture. In some areas these soils are cultivated along with adjoining Barnes and Cresbard soils. Tillage brings material from the claypan into the surface layer, and the soil is hard and cloddy when dry and sticky when wet. These areas are conspicuous in cultivated fields because they occur as slick spots. They are unproductive because of poor tilth, slow permeability, and high salt content.

Typical profile of a Cavour loam in an area of native grasses, about 0.15 mile north and 210 feet west of the SE. corner of sec. 15, T. 136 N., R. 59 W.

A1—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, coarse, subangular blocky structure and weak, medium, crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, irregular boundary.

A2—5 to 6 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; moderate, medium, platy structure; soft when dry, very friable when moist; noncalcareous; clear, irregular boundary.

B21—6 to 10 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; strong, coarse, columnar structure; very hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; clear, wavy boundary.

B22sa—10 to 18 inches, very dark gray (N 3/0) silty clay loam, black (N 2/0) when moist; moderate, medium, angular blocky structure breaking to strong, fine, subangular blocky; very hard when dry, firm when moist, sticky and plastic when wet; many crystals and threads of salts and gypsum; noncalcareous; gradual, wavy boundary.

C1ca—18 to 36 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; many lime concretions; gradual, wavy boundary.

C2—36 to 60 inches, light yellowish-brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) when moist; many, coarse, prominent mottles of yellowish brown (10YR 5/8, moist); massive; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; strongly calcareous; few lime concretions.

The surface layer ranges from 3 to 6 inches in thickness, and the subsurface layer, from less than 1 inch to 2 inches. The subsoil ranges from 6 to 16 inches in thickness, and from silty clay loam to silty clay in texture. The underlying material is moderately saline to strongly saline. It ranges from loam to clay loam in texture.

Cavour soils have a thinner surface layer than Cresbard soils, and the structure of their subsoil differs from that of those soils. Cavour soils developed in glacial till, rather than in glacial melt-water deposits, which was the parent material of Exline soils.

Cavour complex (0 to 3 percent slopes) (Ca).—This complex occurs on glacial till plains, mainly in the central and eastern parts of La Moure County. Cavour loam makes up 75 to 85 percent of the acreage. Included in mapping were small areas of Svea loam, Hamerly loam, and a Tonka silt loam.

This complex is used mainly for hay and pasture. Although it is not suitable for cultivation, some of the complex is used for cultivated crops. There are many slick spots, which are hard and cloddy when dry and sticky when wet. Permeability is slow, and tilth is poor. Trees are poorly suited. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Claire Series

The Claire series consists of well-drained to excessively drained, nearly level to sloping soils on terraces in the James River Valley. These soils formed in coarse-textured glacial outwash. Most areas are in La Moure County.

In a typical profile the surface layer, about 6 inches thick, consists of very dark brown coarse sandy loam. The subsurface layer, about 3 inches thick, consists of very dark brown, very friable coarse sandy loam that has weak, coarse, blocky structure. Below this is loose, dark-brown loamy coarse sand about 8 inches thick. The subsoil of an old buried soil underlies this material. It consists of very dark grayish-brown, very friable loamy coarse sand that has moderate, medium, prismatic structure. The underlying material is loose, varicolored, calcareous fine gravel.

These soils absorb water readily, but they are droughty because the moisture-holding capacity is low. The organic-matter content and the supply of plant nutrients are low.

Most of the acreage is used for hay, but some areas are cultivated. Crops are poorly suited because there is not enough rainfall. These soils are highly susceptible to wind erosion, and management practices that include erosion control are needed.

Typical profile of Claire sandy loam, 800 feet south and 700 feet east of the NW. corner of sec. 17, T. 133 N., R. 60 W.

Ap—0 to 6 inches, very dark brown (10YR 2/2, moist) coarse sandy loam; single grain; loose, nonsticky; abrupt, smooth boundary.

A1—6 to 9 inches, very dark brown (10YR 2/1.5, moist) coarse sandy loam; weak, coarse, blocky structure; very friable; clear, wavy boundary.

C1—9 to 17 inches, dark-brown (10YR 4/3, moist) loamy coarse sand; single grain; loose; clear, smooth boundary.

C2—17 to 34 inches, very dark grayish-brown (10YR 3/2, moist) loamy coarse sand; weak, medium, prismatic structure; very friable, slightly sticky and nonplastic; gradual boundary.

IIC2—34 to 60 inches, varicolored fine gravel; single grain; loose; calcareous.

The surface layer is very dark brown to black in color and sandy loam or coarse sandy loam in texture. It ranges from 2 to 15 inches in thickness. The buried layer ranges from dark brown to very dark grayish brown in color. In places it has weakly developed structure. The underlying material is coarse sand or stratified coarse sand and gravel. Shale fragments are common in the substratum.

Claire soils developed in coarser textured parent material than Maddock and Hecla soils. They are deeper and have a coarser textured subsoil than Arvilla soils.

Claire sandy loam (0 to 8 percent slopes) (Ce).—This soil is on terraces in the James River Valley. Small areas are eroded, and the subsoil is exposed in places. There is an accumulation of soil material along field boundaries and fence lines. Included in mapping were areas, 2 acres or less in size, of an Arvilla sandy loam, a Hecla sandy loam, and a Maddock loamy fine sand.

Most of the acreage is used for hay and pasture, but some areas are cultivated. This soil is droughty and susceptible to wind erosion. It is fairly well suited to crops. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and frequent inclusion of grasses and legumes in the cropping system are practices that help to control erosion and to maintain the organic-matter content and fertility. (Capability unit IIIes-3; Sandy range site; windbreak site 5)

Colvin Series

The Colvin series consists of poorly drained and very poorly drained, nearly level, calcareous soils in shallow depressions and swales, in melt-water channels on glacial lake plains and outwash plains and terraces, and on lower valley side slopes. These soils formed in moderately fine textured melt-water deposits and lake sediments.

In a typical profile the surface layer, about 10 inches thick, consists of dark-gray, slightly calcareous silty clay loam. The next layer, about 8 inches thick, consists of gray, friable, very strongly calcareous silty clay loam that has weak, coarse, prismatic structure breaking to weak, medium, angular blocky. It contains many lime concretions. Below this is light-gray, slightly calcareous, firm silty clay loam. This material contains a few gypsum crystals. It is mottled below a depth of 33 inches.

Permeability is moderately slow. The water table is at or near the surface in spring and after heavy rainfall. It is within 2 or 3 feet of the surface throughout most of the growing season.

Most of the acreage is used for native pasture and hay. The soils are not suitable for cultivated crops unless they are drained.

Typical profile of Colvin silty clay loam, 60 feet east and 70 feet north of the SW. corner of sec. 18, T. 136 N., R. 60 W.

A1—0 to 10 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, crumb structure; hard when dry, friable when moist, sticky and plastic when wet; slightly calcareous; clear, wavy boundary.

C1ca—10 to 18 inches, gray (10YR 6/1) silty clay loam, gray (10YR 5/1) when moist; weak, coarse, prismatic structure breaking to weak, medium, angular blocky; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; common lime concretions; gradual, wavy boundary.

C2g—18 to 33 inches, light-gray (5Y 7/2) silty clay loam, light olive gray (5Y 6/2) when moist; weak, coarse, angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; gradual, wavy boundary.

C3g—33 to 50 inches, light-gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) when moist; many, medium, distinct mottles of dark yellowish brown (10YR 4/4, moist); hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; few gypsum crystals in lower part of horizon; gradual, wavy boundary.

C4g—50 to 60 inches, light-gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) when moist; many, coarse, prominent mottles of dark brown (7.5YR 4/4, moist); hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

The surface layer ranges from 6 to 14 inches in thickness, and from silt loam to silty clay loam in texture. In places this layer is strongly calcareous and contains an accumulation of lime. The C1ca horizon ranges from very dark gray to gray in color and from 6 to 20 inches in thickness. Below a depth of 36 inches the texture ranges from silty clay to coarse sand. Crystals of soluble salts and gypsum occur throughout the profile in some places. The underlying material is very strongly calcareous to slightly calcareous.

Colvin soils are finer textured than Borup soils but are coarser textured than Grano and Hegne soils. They are more poorly drained and contain more mottles than Bearden soils. They have a zone of lime accumulation, which Perella soils lack. The lime is nearer the surface than in Lamoure and Rauville soils.

Colvin silty clay loam (0 to 2 percent slopes) (Ch).—This soil occurs as nearly level areas or depressions on outwash plains and terraces, in melt-water channels and on lake plains. It is poorly drained. Included in mapping were small areas of Bearden silt loam and Borup silt loam.

This soil has the profile described as typical of the series. The surface layer is silty clay loam in most places, but it is silt loam in about 20 percent of the acreage. The water table rises to within 2 feet of the surface during periods of rapid snowmelt or heavy rainfall. The supply of organic matter and plant nutrients is good.

Drained areas are well suited to small grain, corn, flax, millet, and alfalfa; undrained areas are better suited to hay and pasture. The native grasses are mainly big bluestem, switchgrass, prairie cordgrass, lowland sedges, and slender wheatgrass. Some undrained areas are used for small grain or other crops that can be planted late in the season. Erosion is not a problem. (Capability unit IIw-4L; Subirrigated range site; windbreak site 8)

Colvin soils, saline (0 to 2 percent slopes) (Co).—These soils occur as nearly level areas or depressions on lake plains. They are poorly drained. The surface layer is silty clay loam in about 70 percent of the acreage and silt loam in about 30 percent. Included in mapping were areas, less than 2 acres in size, of Bearden silt loam and Borup silt loam.

The dominant soil has a profile like that described as typical of the series, except that it contains enough soluble salts to affect plant growth. The water table is within 2 or 3 feet of the surface throughout most of the growing season.

Most of the acreage is in native grasses, mainly Nuttall alkaligrass, inland saltgrass, western wheatgrass, slender wheatgrass, and plains bluegrass. Drained areas are suit-

able for salt-tolerant crops, such as barley, rye, oats, wheat, alfalfa, and sweetclover. Trees are poorly suited. (Capability unit IIIws-4; Saline Subirrigated range site; windbreak site 8)

Colvin soils, very poorly drained (0 to 2 percent slopes) (Cs).—These soils occur as depressed areas on lake plains and on lower side slopes in the James River Valley.

These soils have a profile like that described as typical of the series, except that in about 10 percent of the acreage the salt content is high enough to affect plant growth. The surface layer is silty clay loam in most places, but it is silt loam in more than 35 percent of the acreage. The water table is at or near the surface throughout most of the growing season.

Nearly all the acreage is in native hay and pasture. The vegetation consists mainly of slough grasses, rushes, and sedges. These soils are too wet to be cultivated, and drainage generally is not practical, because outlets are not available. Trees are not suited. (Capability unit Vw-WL; Wetlands range site; windbreak site 8)

Cresbard Series

The Cresbard series consists of moderately well drained to somewhat poorly drained, nearly level soils in slight depressions on glacial uplands in La Moure and Dickey Counties. These soils have a claypan. They formed in medium-textured to moderately fine textured glacial till.

In a typical profile the surface layer, about 6 inches thick, consists of dark-gray, noncalcareous loam. The subsurface layer, about 1 inch thick, consists of gray, noncalcareous, very friable silt loam that has weak, thin, platy structure. The subsoil, about 17 inches thick, consists of dark grayish-brown, noncalcareous, friable clay loam that has moderate, medium, prismatic structure. The underlying material consists of light yellowish-brown, friable to firm clay loam that contains gypsum crystals. This material is very strongly calcareous to strongly calcareous.

Permeability is slow. The claypan in the subsoil restricts roots and penetration of water. The water table is within 5 feet of the surface in spring.

Most areas of Cresbard soils are cultivated along with adjoining Barnes and Cavour soils. Small grain, flax, corn, and alfalfa are fairly well suited.

Typical profile of a Cresbard loam, about 2,440 feet north and 420 feet east of the SW. corner of sec. 24, T. 134 N., R. 64 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, medium, granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, irregular boundary.

A2—6 to 7 inches, gray (10YR 5/1) silt loam, dark gray (10YR 4/1) when moist; weak, thin, platy structure; soft when dry, very friable when moist; noncalcareous; clear, broken boundary.

B21—7 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 4/3) when moist; upper part of peds coated with gray (10YR 5/1); moderate, medium, prismatic structure breaking to moderate, fine, angular blocky; hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; gradual boundary.

B22—15 to 24 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure breaking to moderate, fine, angular blocky; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; clear, wavy boundary.

C1ca—24 to 48 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) when moist; weak, coarse, prismatic structure breaking to weak, fine, angular blocky; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; common nests of gypsum crystals; gradual, wavy boundary.

C2cs—48 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) when moist; many, medium, distinct mottles of yellowish red (5YR 5/8, moist); massive; hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; many nests of gypsum crystals.

The surface layer ranges from 6 to 10 inches in thickness. The subsurface layer ranges from less than 1 inch to 3 inches in thickness. In some places it is discontinuous and has been mixed with the surface layer in cultivation. The subsoil ranges from 8 to 20 inches in thickness. The underlying material ranges from loam to clay loam in texture.

Cresbard soils are closely associated with Cavour soils, but their subsoil differs in structure from that of those soils. They resemble Aberdeen soils, but they formed in glacial till, rather than in deposits left by glacial melt water. Cresbard soils differ from Svea soils in having a leached subsurface layer and a claypan in the subsoil.

Cresbard, Barnes, and Cavour loams (0 to 3 percent slopes) (Cu).—This unit occurs on glacial till plains throughout La Moure County. Cresbard loam makes up 35 to 65 percent of the unit, Barnes loam 15 to 60 percent, and Cavour loam 5 to 20 percent. Barnes and Cresbard soils are dominant in the western part of La Moure County, and Cresbard and Cavour soils are dominant in the eastern part. In cultivated fields, Cavour soils occur as slick spots that are hard and cloddy when dry and sticky when wet. Included in mapping were small areas of Svea loam, Hamerly loam, and a Tonka loam. Svea loam makes up as much as 10 percent of the acreage in some places.

The Barnes soil is deep. It has high moisture-holding capacity. The Cresbard soil is somewhat droughty because it is moderately deep to a slowly permeable claypan that restricts roots and penetration of water. The Cavour soil has a thin surface layer and a subsoil that contains a dense, slowly permeable claypan.

These soils are fairly well suited to cultivation. Management practices are needed to improve permeability of Cresbard and Cavour soils, to improve tilth, and to maintain organic-matter content and fertility. Among these practices are frequent inclusion of deep-rooted legumes and grasses in the cropping system, stubble-mulch tillage, management of crop residue, and fertilizing. These soils are poorly suited to field or farmstead windbreaks. (Capability unit IIIs-6P; Silty range site; windbreak site 8)

Cresbard and Cavour loams (0 to 3 percent slopes) (Cv).—This undifferentiated unit occurs on glacial till plains in the south-central part of La Moure County near Edgeley and north and east of Oakes in Dickey County. Cresbard loam makes up about 60 percent of the complex, and Cavour loam about 20 percent. Barnes loam, Edgeley loam, Svea loam, and a Tonka silt loam make up the rest.

Most of the acreage is cultivated, but the claypan of the Cresbard and Cavour soils restricts roots and penetration of water. Small grain, flax, and alfalfa are the main crops. Frequent inclusion of deep-rooted legumes and

grasses in the cropping system and application of manure help to improve permeability. Stubble-mulch tillage and management of crop residue help to control wind erosion. Some areas are used for hay and pasture. Trees are poorly suited, but some have been planted for farmstead windbreaks. The hazard of wind erosion is slight. (Capability unit IIIs-6P; Silty range site; windbreak site 8)

Divide Series

The Divide series consists of moderately well drained to somewhat poorly drained, calcareous soils in nearly level areas and slight depressions on outwash plains and stream terraces. These soils formed in medium-textured deposits left by glacial melt water. They are underlain by coarse sand and gravel. They receive seepage from higher lying soils.

In a typical profile the surface layer, about 9 inches thick, consists of very dark gray, weakly calcareous loam. The next layer, about 5 inches thick, consists of gray, strongly calcareous, friable loam that has weak, coarse, prismatic structure. Below this is a layer, about 8 inches thick, of gray, friable, strongly calcareous loam that has weak, coarse, prismatic structure. This is underlain by light-gray, strongly calcareous loamy coarse sand that grades to light olive-brown, slightly calcareous coarse sand and gravel.

Permeability is moderate above the sand and gravel substratum; then it is very rapid. The water table is within 5 feet of the surface most of the year and at or near the surface in spring and early in summer. The moisture-holding capacity is low to moderately high depending on the depth to the gravel substratum.

The soils are somewhat droughty because of the underlying sand and gravel, but most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are fairly well suited. A seasonally high water table provides a good supply of moisture in spring and early in summer.

Typical profile of Divide loam, about 0.5 mile west and 780 feet south of the NE. corner of sec. 7, T. 136 N., R. 60 W.

A1—0 to 9 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, crumb structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; weakly calcareous; gradual, wavy boundary.

ACca—9 to 14 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual, wavy boundary

C1ca—14 to 22 inches, gray (10YR 6/1) loam, dark gray (10YR 4/1) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; clear, wavy boundary.

IIC2—22 to 36 inches, light-gray (2.5Y 7/2) loamy coarse sand, light olive brown (2.5Y 5/4) when moist; single grain; slightly hard when dry, very friable when moist; strongly calcareous; gradual, smooth boundary.

IIC3—36 to 60 inches, light olive-brown (2.5Y 5/6) coarse sand and gravel, light olive brown (2.5Y 5/4) when moist; single grain; loose when dry or moist; slightly calcareous.

The surface layer ranges from 7 to 14 inches in thickness. It is noncalcareous in some profiles and moderately calcareous in others. The ACca horizon ranges from 5 to 18 inches in thickness and from sandy loam to silt loam in texture. The depth to the coarse sand and gravel ranges from 20 to 36 inches. The upper part of this material is strongly calcareous, but it becomes less calcareous with depth.

Divide soils are deeper to sand and gravel than Sioux soils. They are distinguished from Glyndon and Hamerly soils by the substratum of sand and gravel.

Divide loam (0 to 2 percent slopes) (Dd).—This soil is in nearly level areas or in slight depressions on outwash plains and terraces in the central and eastern parts of La Moure County and on low terraces in the James River Valley. Included in mapping were small areas of Renshaw loam and Spottswood loam.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are fairly well suited. This soil is somewhat droughty because of the underlying sand and gravel, and it is moderately susceptible to wind erosion if not protected. Stubble-mulch tillage, management of crop residue, stripcropping, and establishing windbreaks are practices that help to conserve moisture and control wind erosion. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIs-4L; Silty range site; windbreak site 1)

Eckman Series

The Eckman series consists of deep, well-drained soils on uplands scattered throughout La Moure County, on alluvial fans and foot slopes in the James River Valley, and on lake plains. These soils are nearly level, undulating, and sloping. They formed in medium-textured deposits left by glacial melt water.

In a typical profile the surface layer consists of dark-gray loam about 6 inches thick. The subsoil, about 8 inches thick, is dark grayish-brown, friable loam that has moderate, coarse, prismatic structure. The underlying material is light yellowish-brown loam to very fine sandy loam. It is strongly calcareous to a depth of about 22 inches, then it is slightly calcareous. Faint, gray mottles begin at a depth of about 22 inches, and prominent, dark-brown mottles begin at a depth of about 44 inches.

Permeability is moderate, and the moisture-holding capacity is moderately high to high. These soils are well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. These are among the most productive soils in the Survey Area.

Typical profile of an Eckman loam, 950 feet north and 75 feet east of the SW. corner of sec. 4, T. 133 N., R. 61 W.

A1—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, coarse, subangular blocky structure breaking to moderate, medium, crumb; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; clear, smooth boundary.

B2—6 to 14 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure breaking to weak, fine, subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; gradual, wavy boundary.

C1ca—14 to 22 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; weak, coarse, prismatic structure breaking to weak, medium,

subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual, wavy boundary.

C2—22 to 44 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; few, fine, faint mottles of gray (5Y 5/1, moist); weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; smooth, wavy boundary.

C3—44 to 60 inches, light yellowish-brown (2.5Y 6/4) very fine sandy loam, light olive brown (2.5Y 5/4) when moist; few, coarse, prominent, dark-brown (7.5YR 4/4, moist) mottles; slightly hard when dry, friable when moist; slightly calcareous.

The surface layer ranges from 5 to 10 inches in thickness and from very fine sandy loam to silt loam in texture. The subsoil ranges from very dark grayish brown to very dark brown in color and from 7 to 20 inches in thickness. The texture ranges from loam to silt loam. A zone of lime accumulation generally occurs just below the subsoil, but in some profiles it is deeper. The substratum ranges from fine sand to clay loam in texture. In some places the glacial melt-water deposits are underlain by glacial till at a depth of 30 inches or more.

Eckman soils are better drained than Gardena soils, and they generally have a thinner surface layer. They are finer textured than Egeland soils but coarser textured than Great Bend soils. They are similar to Barnes soils, except that they formed in deposits left by glacial melt water rather than in glacial till.

Eckman loam, level (0 to 2 percent slopes) (EaA).—This soil is on alluvial fans in the James River Valley and on lake plains. Included in mapping were areas, less than 2 acres in size, of Gardena loam.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Conservation of moisture and maintenance of the organic-matter content and fertility are the main problems. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help conserve moisture and maintain fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc–6; Silty range site; windbreak site 2)

Eckman loam, gently sloping (3 to 6 percent slopes) (EaB).—This soil is on alluvial fans and side slopes in the James River Valley, on lake plains, and on uplands. Included in mapping were areas, less than 2 acres in size, of Gardena loam and Barnes loam.

The surface layer averages about 7 inches in thickness, but it is thicker on the lower slopes. In some areas glacial till occurs at a depth of about 30 inches. Runoff is medium, and the hazard of water erosion is moderate.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Control of erosion, conservation of moisture, and maintenance of fertility are the main problems. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing are practices that help control erosion, conserve moisture, and maintain fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe–6; Silty range site; windbreak site 2)

Eckman loam, sloping (6 to 8 percent slopes) (EaC).—This soil occupies narrow strips on alluvial fans and side slopes in the James River Valley and on lake plains. Included in mapping were small areas of excessively drained soils that have a thin, dark grayish-brown surface layer.

This soil has a profile similar to that described as typical of the series, except that it is thinner and lime is nearer the surface.

Most of the acreage is cultivated, but careful management is needed. Small grain, flax, and alfalfa are suitable crops. Corn is less well suited because of the erosion hazard. Runoff is somewhat rapid, and control of water erosion is the main management problem. Stubble-mulch tillage, contour tillage, management of crop residue, and fertilizing are practices that help control erosion and maintain fertility. Trees are not well suited. (Capability unit IIIe–6; Silty range site; windbreak site 6)

Edgeley Series

The Edgeley series consists of moderately well drained to well drained, level to undulating soils in La Moure County. These soils formed in medium-textured glacial till overlying shale or shaly glacial till.

In a typical profile the surface layer, about 7 inches thick, consists of dark-gray, noncalcareous loam. The subsoil, about 29 inches thick, consists of friable, noncalcareous loam. The upper part is gray loam that has weak, coarse, prismatic and weak, medium to fine, subangular blocky structure. The lower part is gray loam that has weak, medium, subangular blocky structure. The substratum, about 12 inches thick, consists of gray shaly loam that contains chips of platy shale mixed with loam till. The shaly loam is noncalcareous. This is underlain by gray, noncalcareous clay shale.

Permeability is moderate, and the moisture-holding capacity is moderately low to high, depending on the depth to bedded shale.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Management should include conservation of moisture, control of erosion, and maintenance of fertility.

Typical profile of an Edgeley loam, in a cultivated area about 0.5 mile south and 215 feet west of the NE. corner of sec. 34, T. 133 N., R 64 W.

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, coarse, subangular blocky structure breaking to moderate, fine and very fine, granular; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

B2—7 to 20 inches, gray (2.5Y 6/1) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure and weak, medium to fine, subangular blocky; very hard when dry, friable when moist, sticky and slightly plastic when wet; noncalcareous; contains a few shale chips; clear, smooth boundary.

B3—20 to 36 inches, gray (2.5Y 6/1) loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; shale chips make up 10 to 20 percent, by volume, of this horizon; gradual, wavy boundary.

C1—36 to 48 inches, gray (5Y 5/1) shaly loam, dark olive gray (5Y 3/2) when moist; weak, coarse, blocky structure; platy shale chips mixed with loam till make up 40 to 60 percent of this horizon; noncalcareous; clear, wavy boundary.

IIC2—48 to 60 inches, gray (5Y 5/1 and 6/1) clay shale, dark gray and dark olive gray (5Y 4/1 and 3/2) when

moist; breaks into thin to thick plates; some yellowish-brown (10YR 5/6, moist) stains on plate surfaces; noncalcareous.

The surface layer ranges from 5 to 9 inches in thickness and from loam to silt loam in texture. The subsoil ranges from very dark grayish brown to gray in color and from loam to clay loam in texture. It ranges from 12 to 30 inches in thickness. The depth to the substratum ranges from 2 to 5 feet. Bedded shale is at a depth of more than 36 inches in most places, but in some places it occurs at a depth of about 28 inches.

Edgeley soils have a substratum of shaly till and bedded shale, which is lacking in Barnes and Svea soils.

Edgeley loam, level (0 to 3 percent slopes) (EbA).—This soil occurs on glacial till plains. Included in mapping were small areas of Cresbard loam, a Cavour loam, and a Tonka silt loam.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Conservation of moisture and maintenance of fertility are the main problems. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help conserve moisture and maintain fertility. Trees are well suited. (Capability unit IIc–6; Silty range site; windbreak site 2)

Edgeley loam, undulating (3 to 6 percent slopes) (EbB).—This soil is on low knolls and side slopes along small streams on glacial till plains.

Runoff is medium, and the hazard of water erosion is moderate.

Most of the acreage is cultivated, but some of it is used for native pasture. Small grain, corn, flax, and alfalfa are the main crops. In cultivated areas the main problems are control of erosion, conservation of moisture, and maintenance of fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help control erosion, conserve moisture, and maintain fertility. Trees are well suited. (Capability unit IIe–6; Silty range site; windbreak site 2)

Egeland Series

The Egeland series consists of deep, well-drained, nearly level to sloping soils on uplands and terraces. These soils formed in moderately coarse deposits left by glacial melt water.

The surface layer consists of very dark gray fine sandy loam about 8 inches thick. It is neutral in reaction. The subsoil, about 14 inches thick, consists of dark-gray to grayish-brown, very friable fine sandy loam that has weak, blocky structure and is neutral in reaction. The underlying material is pale-brown to light-gray loamy fine sand to sand that is mildly alkaline to moderately alkaline.

These soils take in water readily, but they have low to moderately high moisture-holding capacity and are somewhat droughty.

Egeland soils are suited to all the crops commonly grown, but they are susceptible to wind erosion when cultivated. Most of the acreage is cultivated.

Typical profile of an Egeland fine sandy loam in a cultivated field, 160 feet north and 0.1 mile west of the SE. corner of sec. 17, T. 130 N., R. 59 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; weak, medium, blocky structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; abundant roots; abrupt, smooth boundary.

B1—8 to 16 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, blocky; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary.

B2—16 to 22 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, blocky; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary.

C1—22 to 36 inches, pale-brown (10YR 6/3) fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; few roots; gradual, wavy boundary.

C2ca—36 to 42 inches, mottled, light-gray (2.5Y 7/2) and pale-brown (10YR 6/3) fine sand, grayish brown (2.5Y 5/2) and brown to dark brown (10YR 4/3) when moist; loose when dry, loose when moist, nonsticky and nonplastic when wet; strongly calcareous; clear, wavy boundary.

C3ca—42 to 60 inches, mottled, light-gray (5Y 7/2) loamy fine sand; olive gray (5Y 5/2) when moist; common, medium, distinct, brownish-yellow (10YR 6/6) mottles; loose when dry, loose when moist, slightly sticky and nonplastic when wet; strongly calcareous.

The surface layer ranges from 6 to 10 inches in thickness and from fine sandy loam to loam in texture. The subsoil ranges from 8 to 20 inches in thickness and from fine sandy loam to sandy loam in texture. The texture of the underlying material ranges from fine sandy loam to fine sand. Glacial till, of loam to clay loam texture, occurs below a depth of 24 inches in some areas.

Egeland soils have a thinner surface layer than Embden soils. They developed in coarser textured material than Eckman soils, and their subsoil is finer textured than that of Maddock soils. They lack the concentration of lime that occurs in the subsoil of Ulen soils and the mottles that occur in the subsoil of Tiffany soils.

Egeland fine sandy loam, sloping (6 to 9 percent slopes) (EcC).—This soil occupies low knolls on sandy uplands in La Moure County and on side slopes of terraces in the James River Valley. Included in mapping were small areas of Embden fine sandy loam on the lower slopes and small areas of a Maddock fine sandy loam on the upper slopes. Also included were small areas where the slope is 9 to 12 percent.

This soil has the profile described as typical of the series. In some of the upland areas, however, loam or clay loam glacial till occurs below a depth of 36 inches.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Yields are somewhat low because the moisture-holding capacity is low. Control of wind erosion is the main problem, and management practices are needed to control erosion. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and frequent inclusion of grass in the cropping system. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIe–3; Sandy range site; windbreak site 6)

Egeland fine sandy loam, till substratum, level (0 to 3 percent slopes) (EdA).—This soil is on sandy uplands in La Moure County. Included in mapping were small areas of Hecla fine sandy loam and a Maddock fine sandy loam.

This soil has a profile similar to the one described as typical of the series, except that loam to clay loam glacial till occurs below a depth of 24 to 36 inches. Permeability is moderately rapid above the glacial till, but moderately slow in the till. The moisture supply is moderately high because the underlying till holds moisture fairly well.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are fairly well suited. Control of wind erosion is the main problem, and management practices are needed to control erosion and conserve moisture. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and frequent inclusion of grass and legumes in the cropping system. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; windbreak site 2)

Egeland fine sandy loam, till substratum, undulating (3 to 6 percent slopes) (EdB).—This soil occurs mainly on sandy uplands in La Moure County. Included in mapping were small areas of Hecla fine sandy loam, a Maddock fine sandy loam, and a Barnes loam.

This soil has a profile similar to the one described as typical of the series, except that loam to clay loam glacial till occurs below a depth of 24 to 36 inches. Permeability is moderately rapid above the glacial till but is moderately slow below the till. The moisture-holding capacity is moderately high because of the underlying till.

Most of the acreage is cultivated, but some small areas are used for hay and pasture. Small grain, corn, flax, and alfalfa grow fairly well. Control of wind erosion is the main problem, and management practices are needed to control erosion and conserve moisture. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and frequent inclusion of grass and legumes in the cropping system. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; windbreak site 2)

Egeland loam, till substratum, undulating (3 to 6 percent slopes) (EeB).—This soil occurs as small scattered areas on uplands in La Moure County. Included in mapping were small areas of an Embden loam and a Barnes loam.

This soil has a profile like that described as typical of the series, except that it has a surface layer of loam and it is underlain by glacial till at a depth of about 24 to 36 inches. Permeability is moderate above the glacial till but is moderately slow below the till. The moisture-holding capacity is moderately high because of the underlying till.

Most of the acreage is cultivated. Under careful management, yields of small grain, corn, flax, and alfalfa are fair to good. Wind erosion and moisture conservation are the main problems, and management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe–5; Silty range site; windbreak site 2)

Egeland-Embden fine sandy loams, level (0 to 3 percent slopes (EgA).—This complex consists of well drained and moderately well drained soils on sandy uplands and terraces in La Moure County. Egeland fine sandy loam makes up about 55 percent of the complex, and Embden fine sandy loam, about 45 percent. Included in mapping were small areas of Tiffany loam, a Maddock fine sandy loam, and an Eckman loam.

These soils have profiles like the ones described as typical of their respective series.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing are practices that help to control erosion, conserve moisture, and maintain fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; Egeland part is in windbreak site 2; Embden part is in windbreak site 1)

Egeland-Embden fine sandy loams, undulating (3 to 6 percent slopes) (EgB).—This complex occurs on sandy uplands and terraces in La Moure County and on lake plains in Dickey County. Egeland fine sandy loam makes up about 80 percent of the complex, and Embden fine sandy loam, about 20 percent. The Egeland soil is on the upper convex slopes, and the Embden soil is on the lower slopes and in small nearly level areas. Included in mapping were small areas of a Maddock fine sandy loam, Tiffany loam, and an Eckman loam.

These soils have profiles like the ones described as typical of their respective series. They have low moisture-holding capacity.

Most of the acreage is used for crops, but some areas are used for hay and pasture. Under careful management, small grain, corn, flax, and alfalfa are fairly well suited. Control of wind erosion is the main problem, and management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; Egeland part is in windbreak site 2; Embden part is in windbreak site 1)

Embden Series

The Embden series consists of deep, moderately well drained, nearly level soils. These soils occur in the south-central part of La Moure County and on lake plains in Dickey County. They formed in moderately coarse textured deposits left by glacial melt water.

In a typical profile the surface layer, about 18 inches thick, consists of very dark gray to dark-gray fine sandy loam. The subsoil, about 20 inches thick, consists of dark grayish-brown to grayish-brown, very friable fine sandy loam. The upper part of the subsoil has weak, coarse, prismatic structure breaking to weak, coarse and medium, blocky. The underlying material consists of light yellowish-brown, strongly calcareous loamy fine sand.

Permeability is moderately rapid, and the moisture-holding capacity is high. These soils are well supplied with organic matter.

Embden soils are suited to all the crops commonly grown in the area. Most of the acreage is in cultivation.

Typical profile of Embden fine sandy loam in a cultivated field, 60 feet north and 225 feet east of the SW. corner of sec. 19, T. 130 N., R. 59 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; moderate, medium, blocky and granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; abrupt, smooth boundary.

A1—6 to 18 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, blocky; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; clear, smooth boundary.

B21—18 to 32 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to weak, coarse and medium, blocky; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; clear, smooth boundary.

B22—32 to 38 inches, grayish-brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; clear, smooth boundary.

C1ca—38 to 46 inches, light yellowish-brown (2.5Y 6/4) loamy fine sand, olive brown (2.5Y 4/4) when moist; single grain; loose when dry or moist, slightly sticky and nonplastic when wet; strongly calcareous; clear, smooth boundary.

C2—46 to 60 inches, mottled, light yellowish-brown (2.5Y 6/4) and pale-yellow (2.5Y 7/4) loamy fine sand, olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) when moist; single grain; loose when dry or moist, slightly sticky and nonplastic when wet; strongly calcareous.

The surface layer ranges from 10 to 20 inches in thickness and from sandy loam to loam in texture. The color ranges from very dark gray to very dark brown. The subsoil ranges from 10 to 20 inches in thickness. It is neutral to mildly alkaline. The texture of the underlying material ranges from fine sand to clay loam glacial till. The depth to lime ranges from 18 to 40 inches.

Embden soils have a thicker surface layer than Egeland soils. They are finer textured than Hecla soils but coarser textured than Gardena soils. They lack the concentration of lime just below the surface layer that occurs in Ulen soils. They have fewer mottles in the subsoil and substratum than Tiffany soils.

Embden fine sandy loam (0 to 2 percent slopes) (Em).—This soil occurs on lake plains. Included in mapping were areas, less than 2 acres in size, of an Egeland fine sandy loam, of Hecla fine sandy loam, and of Gardena loam.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated, but control of wind erosion is a problem. Management practices that control erosion, conserve moisture, and maintain fertility are needed. Among these are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 1)

Embden fine sandy loam, silty substratum (0 to 2 percent slopes) (En).—This soil occurs on lake plains. Included in mapping were areas, less than 2 acres in size, of an Egeland fine sandy loam, of Hecla fine sandy loam, and of Gardena loam.

This soil has a profile like that described as typical of the series, except that, below a depth of about 3 feet, there is a layer of silty clay loam or silt loam about 12 inches thick. Permeability is moderately rapid above the silty layer in the substratum; then it is moderately slow. This soil has higher moisture-holding capacity than is typical, because of the silty substratum.

Most of the acreage is cultivated, but control of wind erosion is a problem. Small grain, corn, flax, and alfalfa are fairly well suited. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 1)

Embden-Gardena loams, till substratum (0 to 3 percent slopes) (Eo).—This complex consists of moderately well drained soils, mainly in the south-central part of La Moure County. Embden loam makes up about 60 percent of the complex, Gardena loam about 30 percent, and small areas of Svea loam, Eckman loam, Egeland loam, and Barnes loam make up the rest.

The Embden soil has a profile like that described as typical of the series, except that the surface layer is loam, and in many places the soil is underlain by glacial till at a depth of about 3 feet. The Gardena soil is a deep, medium-textured soil that has a silty subsoil. In some of the areas it is underlain by fine sandy loam or loamy fine sand at a depth of about 30 inches, and in other places it is underlain by glacial till.

Most of the acreage of this mapping unit is cultivated. Small grain, corn, flax, and alfalfa are well suited. Wind erosion is a moderate hazard because the surface layer is somewhat low in clay content. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-5; Silty range site; windbreak site 1)

Exline Series

The Exline series consists of somewhat poorly drained to poorly drained, claypan soils on stream terraces, outwash plains, and bottom lands in the central and west-central part of La Moure County and on lake plains in Dickey County. These soils formed in medium-textured to moderately fine textured deposits left by glacial melt water and in alluvium. They are level to gently sloping.

In a typical profile the surface layer, about 2 inches thick, consists of dark-gray, noncalcareous silt loam. The subsoil, about 16 inches thick, consists of very dark gray to dark-gray, firm silty clay loam. The upper part has strong, medium, columnar structure, and the lower part has strong, coarse, subangular blocky structure. The underlying material consists of gray, firm, massive silty clay loam that contains distinct mottles of very dark grayish brown in the lower part. The soil material below a depth of 8 inches is slightly calcareous.

Permeability is very slow. The water table is near the surface in spring and within 5 feet of the surface throughout most of the growing season. The capacity to hold water available to plants is low because of the high salt content.

Most of the acreage is used for hay and pasture, but some areas are cultivated. Yields are low because of the high salt content. Areas of Exline soils occur in cultivated fields as small slick spots that are hard and cloddy when dry and sticky when wet.

Typical profile of Exline silt loam, about 0.45 mile east and 50 feet south of the NW. corner of sec. 12, T. 136 N., R. 65 W.

A1—0 to 2 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, medium, subangular blocky structure breaking to moderate, fine, granular; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

B21—2 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; strong, medium, columnar structure breaking to strong, medium, subangular blocky; distinct, continuous clay films on ped faces; hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; clear, wavy boundary.

B22cs—8 to 18 inches, dark-gray (5Y 4/1) silty clay loam, very dark gray (5Y 3/1) when moist; strong, coarse, subangular blocky structure breaking to strong, fine, subangular blocky; distinct, continuous clay films on ped faces; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; many distinct clusters of gypsum crystals; gradual, wavy boundary.

C1csg—18 to 45 inches, gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) when moist; few, fine, faint mottles of grayish brown (2.5Y 5/2, moist); massive; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; gradual, wavy boundary.

C2csg—45 to 60 inches, gray (5Y 5/1) silty clay loam, very dark gray (5Y 3/1) when moist; few, fine, distinct mottles of olive brown (2.5Y 4/4, moist) and common, fine, distinct mottles of very dark grayish brown (10YR 3/2, moist); massive; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

The surface layer ranges from 2 to 6 inches in thickness and from silt loam to silty clay loam in texture. In most cultivated areas tillage has brought a lighter gray material into the surface layer. Beginning at a depth of about 36 inches, the texture ranges from sand to silty clay.

Exline silt loam (0 to 3 percent slopes) (Es).—This soil occurs on stream terraces and broad outwash channels, mainly in the central and west-central parts of La Moure County, on terraces in the James River Valley, and on lake plains. Included in mapping were areas of silty clay loam. Also included were small areas of Aberdeen and Overly soils.

Most of the acreage is used for hay and pasture. Although this soil is not suitable for cultivation, some of the areas are cultivated along with adjoining soils. Tillage brings material from the subsoil into the surface layer, and the soil becomes hard and cloddy when dry and sticky when wet. The salt content is high, permeability is slow, and tilth is poor. If crops are grown, they should be salt-tolerant varieties. Deep-rooted grasses and legumes help to lower the water table and improve tilth and permeability. Trees are poorly suited. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Exline-Lamoure complex (0 to 3 percent slopes) (Ex).—This complex consists of Exline and Lamoure soils on stream terraces, bottom lands, and broad outwash channels in the central and western parts of La Moure County. Exline silt loam makes up about 60 percent of the complex, and Lamoure silt loam and silty clay loam, about 40 percent. Included in mapping were small areas of Aberdeen silt loam and Ryan silty clay.

These soils have the profiles described as typical of their respective series.

Most of the acreage is used for hay and pasture. The native vegetation consists mainly of Nuttall alkaligrass, inland saltgrass, western wheatgrass, big bluestem, switchgrass, and slender wheatgrass. Although this complex is not suitable for cultivation, some small areas are cropped. Tillage brings material from the subsoil into the surface layer of the Exline soil, and the soil is hard and cloddy when dry and sticky when wet. These areas occur as slick spots. They are poorly suited to crops, because of their poor tilth and high salt content. Trees are poorly suited. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Fargo Series

The Fargo series consists of deep, poorly drained soils. These soils occur as nearly level to slightly depressed areas on lake plains in the western part of La Moure County and in shallow basins in the James River Valley. They formed in fine-textured lacustrine sediments.

In a typical profile the surface layer, about 7 inches thick, consists of very dark gray silty clay. The subsoil, about 14 inches thick, consists of dark-gray, slightly calcareous, firm silty clay that has moderate, coarse, angular blocky structure breaking to moderate, fine, angular blocky. The underlying material consists of gray, slightly calcareous, firm to very firm clay and silty clay. This material is mottled below a depth of about 38 inches.

Permeability is slow, and the moisture-holding capacity is high. Water runs off very slowly, and surface drainage is generally needed for successful cultivation. These soils are well supplied with organic matter.

Most of the acreage is cultivated. These soils are fertile, but tillage may be delayed in undrained areas because of wetness. Small grain, flax, corn, and alfalfa are well suited.

Typical profile of Fargo silty clay, 360 feet south and 90 feet east of the NW. corner of sec. 26, T. 133 N., R. 66 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate, coarse, subangular blocky structure breaking to moderate, fine, granular; hard when dry, firm when moist, very sticky and very plastic when wet; abrupt, smooth boundary.

Bg—7 to 21 inches, dark-gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) when moist; moderate, coarse, angular blocky structure breaking to moderate, fine, angular blocky; hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous; gradual, wavy boundary.

C1g—21 to 38 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) when moist; moderate, coarse, subangular blocky structure breaking to moderate, fine, subangular blocky; hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous; gradual, wavy boundary.

C2g—38 to 51 inches, gray (5Y 6/1) silty clay, gray (5Y 5/1) when moist; many, fine, distinct mottles of light olive brown (2.5Y 5/6, moist); very hard when dry, very firm when moist, very sticky and very plastic when wet; slightly calcareous; gradual, wavy boundary.

C3g—51 to 60 inches, gray (5Y 6/1) silty clay, gray (5Y 5/1) when moist; many, medium and coarse, distinct mottles of light olive brown (2.5Y 5/6, moist) and dark brown (7.5YR 4/4, moist); hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous.

The surface layer ranges from 7 to 15 inches in thickness and from silty clay to silty clay loam in texture. The subsoil ranges from 10 to 20 inches in thickness. It is noncalcareous to slightly calcareous. The underlying material is gray or dark gray to olive gray. In some places in the James River Valley, sand and gravel occur below a depth of 2 to 5 feet.

Fargo soils are more poorly drained and have a darker colored subsoil than Nutley soils. They lack the concentration of lime that Hegne soils have. They are finer textured than Overly and Perella soils. Fargo soils are similar to Ludden soils, but Ludden soils are dark colored to a greater depth.

Fargo silty clay (0 to 2 percent slopes) (Fc).—This soil occurs in the James River Valley. Included in mapping were areas, less than 2 acres in size, of LaDelle silty clay loam.

All of the acreage is cultivated. It is well supplied with organic matter and plant nutrients. The moisture-holding capacity is high. Small grain, corn, flax, and alfalfa are the main crops. Draining these areas and maintaining good tilth are the main problems. Trees are well suited. (Capability unit IIwe-4; Clayey range site; windbreak site 1)

Fargo and Hegne silty clays (0 to 3 percent slopes) (Fh).—This undifferentiated unit consists of deep, fine-textured soils in the western part of La Moure County. Fargo silty clay is the dominant soil, but in some areas Hegne silty clay makes up as much as 50 percent of the acreage. Included in mapping were small areas of a Nutley silty clay.

These soils have the profiles described as typical of their respective series.

Most of the acreage is cultivated. Small grain, flax, and alfalfa are the main crops. The moisture-holding capacity is high. Draining these areas and maintaining good tilth and fertility are the main problems. These soils are moderately susceptible to wind erosion if they are fall plowed, because the silty clay surface layer slakes down into sand-sized particles. Stubble-mulch tillage and management of crop residue help to control erosion. Trees are well suited. (Capability unit IIwe-4; Clayey range site; windbreak site 1)

Fordville Series

The Fordville series consists of well-drained soils that occur on terraces in the James River Valley and on outwash plains. These soils formed in medium-textured glacial outwash overlying coarse sand and gravel. They are nearly level to gently sloping.

In a typical profile the surface layer, about 10 inches thick, consists of dark-gray loam. The subsoil, about 6 inches thick, consists of grayish-brown, friable loam that has moderate, medium, prismatic structure. The next layer, about 6 inches thick, consists of light brownish-gray, friable loam that is very strongly calcareous. This layer contains segregated lime. Below this is light brownish-gray to light-gray very coarse sand and gravel. The upper part of the underlying material is strongly calcareous; the lower part is slightly calcareous.

Permeability is moderate above the coarse sand and gravel; then it is very rapid. The moisture-holding capacity is low to moderately high, depending on the depth to the coarse sand and gravel. These soils are somewhat droughty.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops.

Typical profile of Fordville loam in a cultivated field, 450 feet north and 0.1 mile east of the SW. corner of the NW¼ sec. 18, T. 130 N., R. 59 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; moderate, medium, blocky and granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; clear, smooth boundary; sodium adsorption ratio 0.5.

A1—6 to 10 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; moderate, medium, blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary; sodium adsorption ratio 0.6.

B—10 to 16 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, smooth boundary; sodium adsorption ratio 1.0.

C1ca—16 to 22 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many, coarse, distinct segregations of white lime; few roots; very strongly calcareous; clear, smooth boundary; sodium adsorption ratio 0.6.

IIC2—22 to 42 inches, light brownish-gray (2.5Y 6/2) very coarse sand and fine gravel, dark grayish brown (2.5Y 4/2) when moist; loose when dry, loose when moist, nonsticky and nonplastic when wet; strongly calcareous; gradual, smooth boundary; sodium adsorption ratio 0.7.

IIIC3—42 to 60 inches, light-gray (2.5Y 7/2) coarse and fine gravel, dark grayish brown (2.5Y 4/2) when moist; loose when dry, loose when moist, nonsticky and nonplastic when wet; slightly calcareous; sodium adsorption ratio 0.8.

The soil material above the coarse sand and gravel ranges from 20 to 36 inches in thickness. The surface layer ranges from 4 to 18 inches in thickness. In some profiles thin clay films occur on ped surfaces. The upper part of the substratum is a transitional layer between the subsoil and the coarse sand and gravel below. This transitional layer ranges from light brownish gray to dark grayish brown. The texture ranges from loam to sandy loam, and the thickness from 4 to 10 inches. Beneath this layer is stratified coarse sand and gravel that is calcareous in the upper part. Lime coatings occur on some of the sand grains and the gravel. Shale fragments are common.

Fordville soils are deeper over gravel than Sioux and Renshaw soils. They have a thinner surface layer than Spottswood soils. Segregated lime occurs deeper in the profile than in Divide soils.

Fordville loam, level (0 to 2 percent slopes) (FvA).—This soil occurs on terraces in the James River Valley and on outwash plains. Included in mapping were areas, 2 acres or less in size, of a Renshaw loam and an Eckman loam.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated. Small grains, corn, and alfalfa are the main crops. Management practices are needed to conserve moisture, control wind erosion, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIs–5; Silty range site; windbreak site 5)

Fordville loam, gently sloping (3 to 5 percent slopes) (FvB).—This soil is on terraces and foot slopes in the James River Valley and on outwash plains. Included in mapping were areas, less than 2 acres in size, of a Renshaw loam and an Eckman loam.

This soil has a profile like that described as typical of the series, except that the surface layer is not so thick.

Most of the acreage is cultivated, but some of it is used for hay and pasture. Small grain, flax, corn, and alfalfa are the crops commonly grown. This soil is somewhat droughty. Management practices are needed to conserve moisture, control erosion, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees are fairly well suited. (Capability unit IIIes–5; Silty range site; windbreak site 5)

Fresh Water Marsh

Fresh water marsh (Fw) consists of shallow lakes and depressions that are wet throughout most of the year (fig. 4). The vegetation consists of bulrushes, cattails, reeds, and other aquatic plants that have little or no value as livestock feed. These areas are valuable as a habitat for wildlife. (Capability unit VIIIw–1)

Gardena Series

The Gardena series consists of deep, moderately well drained, nearly level to gently sloping soils on uplands in La Moure and Dickey Counties and on terraces and lower foot slopes in the James River Valley. These soils are medium textured. They formed in deposits left by glacial melt water. (fig. 5).

In a typical profile the surface layer, about 7 inches thick, consists of very dark gray loam. The subsurface layer, about 5 inches thick, consists of very dark gray, friable loam that has moderate, medium, blocky structure. The subsoil, about 13 inches thick, consists of dark grayish-brown, friable loam that has moderate, coarse, prismatic structure. It contains a few segregations of lime in the lower part and is very slightly calcareous. The underlying material consists of mottled, light olive-brown, pale-yellow, and white loam and very fine sandy loam. This material contains gypsum crystals. It is very strongly calcareous to strongly calcareous.

Permeability is moderate, and the moisture-holding capacity is high. These soils are well supplied with organic matter and plant nutrients.

Gardena soils are well suited to all the crops commonly grown in the Area. Most of the acreage is cultivated.

Typical profile of Gardena loam in a cultivated field, 180 feet south and 0.1 mile east of the NW. corner of sec. 25, T. 129 N., R. 60 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam, black 10YR 2/1) when moist; moderate, medium, blocky and granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; abrupt, smooth boundary.

A1—7 to 12 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; moderate, medium, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; clear, wavy boundary.

Figure 4.—A typical view of Fresh water marsh. The vegetation is mainly bulrushes and cattails.

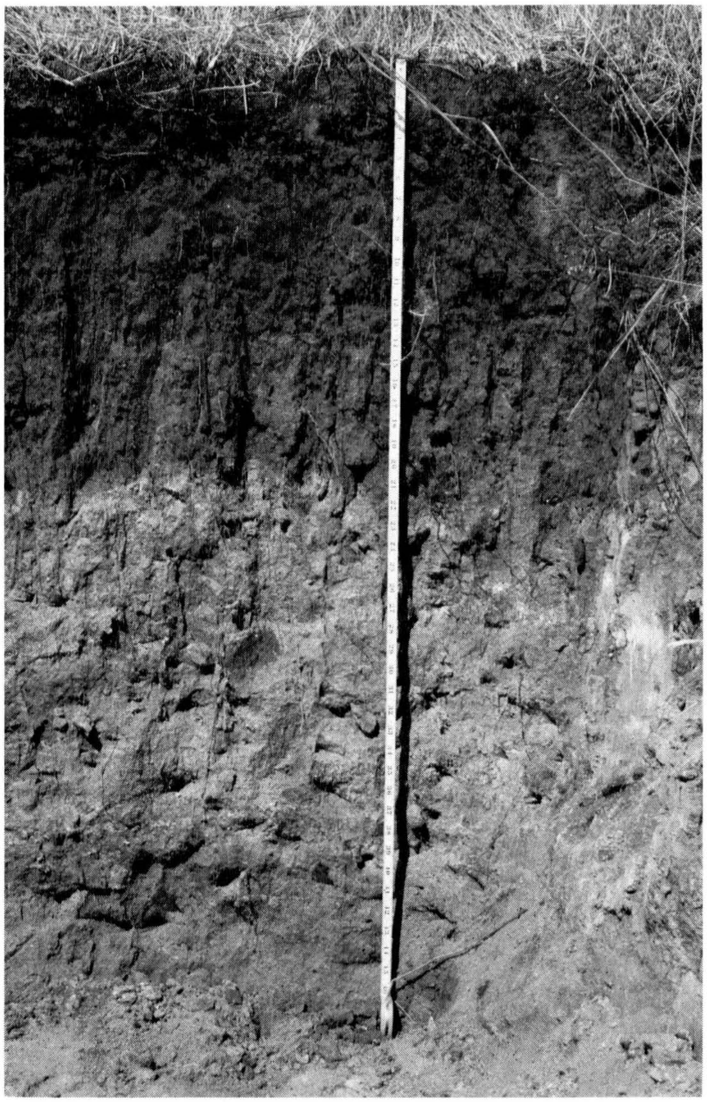

Figure 5.—Profile of Gardena loam.

B—12 to 25 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; very slightly calcareous in the lower part; few, medium, distinct segregations of lime; clear, wavy boundary.

C1ca—25 to 38 inches, pale-yellow (5Y 7/3) loam, light olive brown (2.5Y 5/4) when moist; moderate, coarse, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few roots; very strongly calcareous; a few clusters of gypsum crystals; gradual, wavy boundary.

C2—38 to 50 inches, pale-yellow (2.5Y 7/4) very fine sandy loam, light olive brown (2.5Y 5/4) when moist; few, medium, distinct, yellowish-brown (10YR 5/8) and white (N 8/0) mottles; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; clear, wavy boundary.

C3cs—50 to 54 inches, mottled, pale-yellow (5Y 7/3) and white (N 8/0) very fine sandy loam, olive gray (5Y 5/2) and light gray to gray (5Y 6/1) when moist; many, medium, distinct, yellowish-brown (10YR 5/6 and 5/8) mottles; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; a few clusters of gypsum crystals; clear, wavy boundary.

C4—54 to 60 inches, mottled, pale-yellow (2.5Y 7/4) and white (5Y 8/2) very fine sandy loam, light olive brown (2.5Y 5/4) and light gray (5Y 7/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/6 and 5/8) mottles; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; a few gypsum crystals.

The surface layer ranges from 7 to 20 inches in thickness and from very fine sandy loam to silt loam in texture. The subsoil ranges from loam to light clay loam in texture and from 10 to 20 inches in thickness. The texture of the underlying material ranges from fine sand to silty clay loam. The lime zone generally occurs just below the subsoil, but some profiles are leached to a greater depth. In some places glacial till begins at a depth of about 30 inches.

Gardena soils have a thicker surface layer than Eckman soils. They are finer textured than Embden soils but are coarser textured than Overly soils. They are better drained and less mottled than Tiffany soils. They differ from Svea soils in having developed in deposits left by glacial melt water, rather than in glacial till.

Gardena loam (0 to 2 percent slopes) (Ga).—This soil occurs on foot slopes and alluvial fans in the James River Valley and on lake plains. Included in mapping were areas, less than 2 acres in size, of an Eckman loam, Glyndon silt loam, an Embden loam, and Overly silt loam.

This soil has a profile similar to that described as typical of the series, except that in some areas thin layers of fine sand occur below a depth of 36 inches.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are well suited. Management practices are needed to conserve moisture and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing. Trees are well suited. (Capability unit IIc–6; Silty range site; windbreak site 1)

Gardena loam, gently sloping (3 to 5 percent slopes) (GaB).—This soil occurs on foot slopes and alluvial fans in the James River Valley. Included in mapping were areas, less than 2 acres in size, of an Eckman loam and Glyndon silt loam.

This soil has a profile like that described as typical of the series, except that the surface layer is not so thick and in some places the substratum contains thin layers of fine sand.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. This soil is somewhat susceptible to water erosion. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, contour tillage, stripcropping, establishing windbreaks, and fertilizing. Trees are well suited. (Capability unit IIe–6; Silty range site; windbreak site 1)

Gardena loam, silty substratum (0 to 2 percent slopes) (Gb).—This soil occurs on lake plains. Included in mapping were areas, less than 2 acres in size, of Overly silt loam and Glyndon silt loam.

This soil has a profile like that described as typical of the series, except that there is a layer of slowly permeable silty clay loam at a depth of about 40 inches. The moisture-holding capacity is high.

All the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Management practices

are needed to conserve moisture and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, and fertilizing. Trees are well suited. (Capability unit IIc-6; Silty range site; windbreak site 1)

Gardena loam, till substratum (0 to 3 percent slopes) (Gc).—This soil occurs in the northeastern part of La Moure County. Included in mapping were small areas of Glyndon silt loam and Spottswood loam.

This soil has a profile like that described as typical of the series, except that the substratum consists of a thin layer of coarse sand underlain at a depth of about 42 inches by clay loam glacial till. Permeability is slow in the till substratum. This soil has a seasonally high water table that rises to within 3 feet of the surface.

Most of the acreage is cultivated, but some areas are used for hay and pasture. Small grain, corn, flax, and alfalfa are well suited. Management practices are needed to conserve moisture and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, and fertilizing. Trees are well suited. (Capability unit IIc-6; Silty range site; windbreak site 1)

Gardena and Eckman loams, level (0 to 3 percent slopes) (GeA).—This undifferentiated unit consists of deep, moderately well drained and well drained soils on uplands, mainly in the central and eastern parts of La Moure County. It formed in deposits left by glacial melt water. Gardena loam makes up about 60 percent of the acreage, and Eckman loam about 40 percent. Any given area, however, may be dominantly Gardena loam or dominantly Eckman loam. Included in mapping were small areas of Embden loam, a Barnes loam, and Svea loam.

These soils have profiles like the ones described as typical of their respective series.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Management practices are needed to conserve moisture and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, and fertilizing. Trees are well suited. (Capability unit IIc-6; Silty range site; Gardena part is in windbreak site 1; Eckman part is in windbreak site 2)

Glyndon Series

The Glyndon series consists of deep, moderately well drained to somewhat poorly drained soils on uplands, terraces, and lake plains throughout the Survey Area. These soils are nearly level to gently sloping. They formed in medium-textured deposits left by glacial melt water.

In a typical profile the surface layer, about 8 inches thick, consists of very dark gray, slightly calcareous silt loam. The subsurface layer, about 6 inches thick, consists of gray, friable, strongly calcareous silt loam that has weak, medium, subangular blocky structure. The underlying material consists of light yellowish-brown and pale-yellow silt loam and loam. This material is strongly to slightly calcareous. This material is mottled below a depth of about 30 inches.

Permeability is moderate, and the moisture-holding capacity is high. The water table is within 5 feet of the surface most of the year and at or near the surface in spring. These soils are well supplied with organic matter and plant nutrients. They have a high content of lime. Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are suitable crops.

Typical profile of Glyndon silt loam, about 2,040 feet west and 1,840 feet south of the NE. corner of sec. 33, T. 134 N., R. 62 W.

A11—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, crumb structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; clear, wavy boundary.

A12ca—8 to 14 inches, gray (10YR 5/1) silt loam, dark gray (10YR 4/1) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; clear, wavy boundary.

C1ca—14 to 30 inches, light yellowish-brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual, wavy boundary.

C2—30 to 36 inches, light yellowish-brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6, moist); slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; gradual, wavy boundary.

C3—36 to 40 inches, pale-yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) when moist; common, medium, distinct mottles of yellowish brown (10YR 5/6, moist); hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; gradual, wavy boundary.

C4—40 to 60 inches, light yellowish-brown (2.5Y 6/4) loamy fine sand, olive brown (2.5Y 4/4) when moist; loose when dry, very friable when moist; slightly calcareous.

The surface layer ranges from 6 to 15 inches in thickness. The underlying material is strongly calcareous to slightly calcareous. Coarse sand and fine gravel occur below a depth of 36 inches in some places. In most places on lake plains, the texture ranges from loam just below the subsoil to fine sand at a depth of about 5 feet. In some places there is a layer of silty clay loam at a depth of about 40 inches.

Glyndon soils are finer textured than Ulen soils but are coarser textured than Bearden soils. They are better drained than Borup soils, and they have fewer mottles in the substratum than those soils.

Glyndon silt loam (0 to 3 percent slopes) (Gl).—This soil occurs mainly on lake plains in Dickey County and on outwash plains and terraces in La Moure County. Included in mapping were small areas of Gardena loam, Bearden silt loam, Borup silt loam, and Ulen fine sandy loam.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated, but a few small areas are used for hay and pasture. Small grain, corn, flax, and alfalfa are well suited. This soil is moderately susceptible to wind erosion, especially where the limy material has been brought to the surface in cultivation. The high content of lime causes granulation of the surface layer, and the soil slakes down into sand-sized particles that blow easily. Management practices are needed to control wind erosion and maintain the organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, inclusion of grasses and legumes in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-4L; Silty range site; windbreak site 1)

Glyndon silt loam, gently sloping (3 to 6 percent slopes) (GlB).—This soil occurs as narrow areas on lower foot slopes and on terraces in the James River Valley and on lake plains. Included in mapping were areas, less than 2 acres in size, of Gardena loam and Borup silt loam.

This soil has a profile like that described as typical of the series, except that the surface layer is thinner in most places.

Most of the acreage is cultivated, but some areas are used for hay and pasture. Small grain, corn, flax, and alfalfa are well suited. This soil is moderately susceptible to water erosion. It is also susceptible to wind erosion, especially in areas where the limy material has been brought to the surface in cultivation. The high content of lime causes the surface soil to slake down into sand-sized particles that blow easily. Management practices are needed to control erosion and to maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, contour tillage, establishing windbreaks, inclusion of grass and legumes in the cropping system, and fertilizing. Trees are well suited. (Capability unit IIe-4L; Silty range site; windbreak site 1)

Glyndon silt loam, saline (0 to 2 percent slopes) (Gm).—This soil occurs on lake plains. Included in mapping were areas, less than 2 acres in size, of Colvin soils, saline, and Bearden silt loam, saline.

This soil has a profile like that described as typical of the series, except that the surface layer and the upper part of the substratum contain enough salt to affect plant growth.

Most of the acreage is used for hay, but some areas are cultivated. Salt-tolerant crops, such as barley, rye, oats, wheat, sweetclover, millet, and alfalfa, are suitable. Management practices are needed to improve subsurface drainage, control erosion, and maintain fertility. Inclusion of deep-rooted legumes in the cropping system helps to lower the water table and remove salts from the surface layer. Other beneficial practices include the application of manure, stubble-mulch tillage, management of crop residue, and fertilizing. Trees are poorly suited. (Capability unit IIIs-4; Saline Subirrigated range site; windbreak site 8)

Glyndon silt loam, silty substratum (0 to 2 percent slopes) (Gn).—This soil occurs on lake plains. Included in mapping were areas, less than 2 acres in size, of Gardena loam, Barden silt loam, and Ulen fine sandy loam.

This soil has a profile like that described as typical of the series, except that it has a layer of moderately slowly permeable silty clay loam at a depth of about 40 inches. The moisture-holding capacity is high.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are well suited. This soil is moderately susceptible to wind erosion, especially in areas where cultivation has brought limy material to the surface. The high content of lime causes the surface soil to slake down into sand-sized particles that blow easily. Management practices are needed to control erosion and maintain fertility. Among these practices are stubble-mulch tillage, stripcropping, management of crop residue, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-4L; Silty range site; windbreak site 1)

Grano Series

The Grano series consists of very poorly drained, calcareous soils in level, clay-filled basins in the western part of La Moure County. These soils formed in fine-textured lacustrine sediments.

In a typical profile the surface layer, about 16 inches thick, consists of dark-gray silty clay that is slightly calcareous. This is underlain by a layer, about 20 inches thick, of gray, strongly calcareous silty clay that has strong, fine, angular blocky structure. Below this is gray silty clay that contains light olive-brown mottles.

Permeability is slow, and the soils have a high water table. The supply of organic matter and plant nutrients is good.

Grano soils are used for hay and pasture. Undrained areas are too wet for cultivation.

Typical profile of Grano silty clay, about 1,790 feet north and 90 feet east of the SW. corner of sec. 26, T. 135 N., R. 66 W.

A1—0 to 16 inches, dark-gray (5Y 4/1) silty clay, black (5Y 2/1) when moist; weak, coarse, prismatic structure breaking to strong, fine, angular blocky; hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous; clear, wavy boundary.

C1ca—16 to 36 inches, gray (5Y 5/1) silty clay, olive gray (5Y 4/2) when moist; strong, fine, angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous.

C2g—36 to 60 inches, gray (5Y 5/1) silty clay, olive gray (5Y 5/2) when moist; many, coarse, prominent mottles of light olive brown (2.5Y 5/6, moist); massive; hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous.

The surface layer ranges from 8 to 16 inches in thickness. In some places the lower part contains accumulated lime. The upper part of the substratum ranges from 10 to 24 inches in thickness. It is strongly to very strongly calcareous. The lower part of the substratum is slightly to strongly calcareous.

Grano soils have more mottles in the substratum and are more poorly drained than Hegne soils. They have a lime accumulation, which is lacking in Fargo soils. Grano soils are finer textured than Colvin soils.

Grano silty clay (0 to 2 percent slopes) (Go).—This soil occupies clay-filled basins in the western part of La Moure County. Included in mapping were small areas of Hegne soils.

This soil is used mainly for hay and pasture. Undrained areas are too wet for cultivation, and drainage is not practical, because outlets are lacking. The native vegetation consists mainly of rivergrass, American mannagrass, prairie cordgrass, sedges, and rushes. (Capability unit Vw-WL; Wetlands range site; windbreak site 7)

Gravel Pits

Gravel pits (Gp) are open excavations from which sand and gravel have been removed. Pits that are less than 3 acres in size are shown by symbols on the detailed soil map at the back of this publication.

Great Bend Series

The Great Bend series consists of well-drained, nearly level, gently sloping and undulating soils on lake plains in the western part of La Moure County and on side slopes in the James River Valley. These soils formed in

moderately fine textured deposits left by glacial melt water.

In a typical profile the surface layer, about 6 inches thick, consists of noncalcareous, very dark gray silty clay loam. The subsoil is about 12 inches thick. The upper part consists of dark grayish-brown, noncalcareous, friable clay loam that has moderate, medium, prismatic structure. The lower part is light olive-brown, noncalcareous, friable silty clay loam that has moderate, medium, prismatic structure. The upper part of the underlying material is light yellowish-brown, very strongly calcareous silt loam that contains accumulated lime. The lower part is light yellowish-brown, friable, strongly calcareous silty clay loam that is mottled with yellowish brown.

Permeability is moderate in the surface layer and moderately slow in the subsoil and substratum. The moisture-holding capacity is high. These soils are well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated. These soils are well suited to all crops commonly grown in the Survey Area. Wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Good management practices are needed to help control runoff and erosion and to maintain fertility.

Typical profile of Great Bend silty clay loam, about 0.3 mile north and 65 feet west of the SE. corner of sec. 14, T. 133 N., R. 66 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium, granular structure to crumb structure; soft when dry, friable when moist, sticky and plastic when wet; noncalcareous; clear, smooth boundary.

B21—6 to 12 inches, dark grayish-brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, angular blocky; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

B22—12 to 18 inches, light olive-brown (2.5Y 5/4) silty clay loam, olive brown (2.5Y 4/4) when moist; moderate, medium, prismatic structure breaking to moderate, medium, angular blocky; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; clear, wavy boundary.

C1ca—18 to 34 inches, light yellowish-brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) when moist; weak, medium, prismatic structure breaking to weak, medium, angular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; few distinct lime concretions; gradual, wavy boundary.

C2—34 to 60 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) when moist; common, coarse, prominent mottles of dark yellowish brown (10YR 4/4, moist); massive; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous.

The surface layer ranges from 6 to 10 inches in thickness. The subsoil ranges from very dark brown to olive brown in color and from silty clay loam to clay loam in texture. It ranges from 6 to 14 inches in thickness. In some places the lower part contains an accumulation of lime and is strongly calcareous. The underlying material has an accumulation of lime just below the subsoil in most places. Glacial till occurs below a depth of 30 inches in some places.

Great Bend soils have a thinner surface layer than Overly soils. They are coarser textured than Nutley soils but are finer textured than Eckman soils. Great Bend soils formed in sediments left by glacial melt water, rather than in glacial till, which was the parent material of Barnes soils.

374-278—71——3

Great Bend silty clay loam, gently sloping (3 to 5 percent slopes) (GrB).—This soil occurs on long, gentle slopes along a tributary of the James River, in Dickey County. Included in mapping were areas, less than 2 acres in size, of Overly, Bearden, and Eckman soils.

This soil has the profile described as typical of the series. Runoff is medium, and the soil is moderately susceptible to water erosion. The moisture-holding capacity is high, and the soil is moderately and moderately slowly permeable.

This soil is well suited to cultivation. Wheat, oats, barley, rye, flax, corn, and alfalfa are suitable crops. The main problem is control of water erosion. Other problems are conservation of moisture and maintenance of organic-matter content and fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help control erosion, conserve moisture, and maintain the organic-matter content and fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-6; Clayey range site; windbreak site 2)

Great Bend-Barnes complex, level (0 to 3 percent slopes) (GtA).—This complex consists of deep, well-drained soils on uplands in the western part of La Moure County. Great Bend silty clay loam makes up about 50 percent of the complex, and Barnes clay loam about 45 percent. Included in mapping were small areas of an Overly silty clay loam and a Nutley silty clay.

The Great Bend soil has a profile like that described as typical of the series, except that the substratum is clay loam glacial till, rather than silty deposits left by glacial melt water. The Barnes soil has a clay loam surface layer and subsoil, but its profile is otherwise like that described as typical of the series. The moisture-holding capacity is high. Permeability is moderate in the Barnes soil and moderate to moderately slow in the Great Bend soil.

This complex is well suited to cultivation. Wheat, oats, barley, rye, flax, corn, and alfalfa are suitable crops. The main problems are conservation of moisture and maintenance of organic-matter content and fertility. Erosion is not a problem. Stubble-mulch tillage, management of crop residue, and fertilizing are practices that help conserve moisture and maintain fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc-6; Clayey range site; windbreak site 2)

Great Bend-Barnes complex, undulating (3 to 6 percent slopes) (GtB).—This complex consists of deep, well-drained soils on uplands in the western part of La Moure County. Great Bend silty clay loam makes up about 50 percent of the complex, and Barnes clay loam about 45 percent. Included in mapping were small areas of an Overly silty clay loam and a Nutley silty clay.

The Great Bend soil has a profile like that described as typical of the series, except that the substratum consists of clay loam glacial till rather than silty deposits left by glacial melt water. Except for the texture of the surface layer, the Barnes soil has the profile described as typical of the series. The moisture-holding capacity is high. Permeability is moderate in the Barnes soil and moderate to moderately slow in the Great Bend soil.

This complex is well suited to cultivation. Wheat, oats, barley, rye, flax, corn, and alfalfa are suitable crops. Control of water erosion is the main problem. Other problems are conservation of moisture and maintenance

of organic-matter content and fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are practices that help control erosion, conserve moisture, and maintain fertility. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-6; Clayey range site; windbreak site 2)

Hamar Series

The Hamar series consists of deep, somewhat poorly drained soils on sandy uplands in La Moure and Dickey Counties and on sandy terraces in the James River Valley. These soils occur as nearly level areas or as slight depressions. They formed in coarse-textured deposits left by glacial melt water.

In a typical profile the surface layer, about 6 inches thick, consists of very dark gray loamy fine sand. The subsoil, about 6 inches thick, consists of mottled, very dark gray, very friable loamy fine sand that has weak, blocky structure or is single grain. The underlying material is mottled, light-gray fine sand that is calcareous or strongly calcareous below a depth of 34 inches.

Permeability is rapid. The water table is within 5 feet of the surface most of the year and at or near the surface in spring.

Most of the acreage is cultivated along with surrounding areas of Hecla, Maddock, and Ulen soils. In undrained areas wetness sometimes delays spring planting and fall harvesting in years when rainfall is above average. The additional moisture is beneficial to crops in dry years.

Typical profile of Hamar loamy fine sand, 0.1 mile north and 200 feet east of the SW. corner NW¼ sec. 11, T. 129 N., R. 59 W.

A1—0 to 6 inches, very dark gray (10YR 3/1) loamy fine sand, black (10YR 2/1) when moist; weak, medium and fine, blocky structure and single grain; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; abundant roots; gradual, smooth boundary.

Bg—6 to 12 inches, mottled, very dark gray (10YR 3/1) loamy fine sand, very dark brown (10YR 2/2) when moist; many, fine, faint, dark-brown (10YR 3/3, moist) mottles; weak, medium, blocky structure and single grain; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; plentiful roots; clear, wavy boundary.

C1g—12 to 24 inches, mottled, light-gray (2.5Y 7/2) fine sand, light brownish gray (2.5Y 6/2) when moist; common, fine, faint, dark-brown (10YR 3/3, moist) and brown to dark-brown (10YR 4/3, moist) mottles; very weak, medium, blocky structure and single grain; soft when dry, loose when moist, nonsticky and nonplastic when wet; few roots; gradual, wavy boundary.

C2g—24 to 34 inches, mottled, light-gray (2.5Y 7/2) fine sand, light brownish gray (2.5Y 6/2) when moist; common, medium, faint, dark yellowish-brown (10YR 4/4, moist) mottles; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; few roots; clear, wavy boundary.

C3ca—34 to 48 inches, mottled, light-gray (5Y 7/2) fine sand, olive gray (5Y 5/2) when moist; few, fine, faint lime segregations; few, medium, faint, dark grayish-brown (10YR 4/2, moist) mottles, and few, medium, prominent, black (N 2/0, moist) mottles; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; strongly calcareous; gradual, wavy boundary.

C4ca—48 to 54 inches, mottled, light-gray (5Y 7/2) fine sand. olive gray (5Y 5/2) when moist; common, medium, prominent, black (N 2/0, moist) mottles and common, medium, distinct, dark-brown (7.5YR 3/2, moist) mottles; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; strongly calcareous; clear, wavy boundary.

C5g—54 to 60 inches, mottled, light-gray (5Y 7/2) fine sand, olive gray (5Y 5/2) when moist; few, fine, faint, light olive-brown (2.5Y 5/4, moist) mottles and few, fine, distinct, dark-brown (7.5YR 3/2, moist) mottles; soft when dry, loose when moist, nonsticky and nonplastic when wet; calcareous.

The surface layer ranges from black to very dark grayish brown in color and from fine sandy loam to fine sand in texture. The thickness ranges from 2 to 24 inches. The subsoil ranges from very dark gray to very dark brown in color and from 4 to 18 inches in thickness. The texture ranges from fine sandy loam to fine sand. The underlying material ranges from dark grayish brown to olive in color and from loamy fine sand to fine sand in texture. Loam or clay loam glacial till occurs at a depth below 30 inches in places on sandy uplands. A layer of silty clay loam, silt loam, or very fine sandy loam, about 12 inches thick, occurs at a depth below 40 inches in some profiles.

Hamar soils have a more strongly mottled subsoil and substratum than Hecla and Maddock soils. They lack the accumulation of lime that occurs just below the surface layer of Arveson and Ulen soils. Hamar soils are not so strongly mottled in the subsoil as Venlo soils. They are coarser textured than Tiffany soils.

Hamar fine sandy loam (0 to 3 percent slopes) (Ha).—This soil occurs in shallow depressions on sandy uplands in the southeastern part of La Moure County and on terraces in the James River Valley. Included in mapping were small areas of Hecla loamy fine sand and Embden fine sandy loam.

This soil has a profile like that described as typical of the series, except for the texture of the surface layer. In some areas loam or clay loam glacial till occurs below a depth of about 36 inches.

Most of the acreage is cultivated along with surrounding areas of Hecla and Maddock soils. The water table is high, and wetness sometimes causes delay in spring planting and fall harvesting. Management practices are needed to improve subsurface drainage, control wind erosion, and maintain fertility. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing are beneficial practices. Trees are well suited. (Capability unit IIIwe-3: Subirrigated range site; windbreak site 7)

Hamar loamy fine sand (0 to 2 percent slopes) (He).—This soil occurs as shallow depressions in the sandy part of lake plains. It is surrounded by slightly higher lying Hecla and Ulen soils, and small areas of these soils were included in mapping.

This soil has a profile like that described as typical of the series, except that in a few areas a layer of very fine sandy loam, silt loam, or silty clay loam occurs at a depth of about 40 inches.

The water table is high, and wetness sometimes causes delay in spring planting and fall harvesting.

Most of the acreage is cultivated, but this soil is highly susceptible to wind erosion if not protected. Management practices are needed to improve subsurface drainage, control wind erosion, and maintain fertility. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, fertilizing, and frequent inclusion of grasses in the cropping system are beneficial practices.

Some areas are used for hay and pasture. Trees are well suited. (Capability unit IVe–2; Subirrigated range site; windbreak site 7)

Hamerly Series

The Hamerly series consists of moderately well drained to somewhat poorly drained, nearly level to undulating soils on uplands, mainly in the northeastern part of La Moure County. These soils formed in medium-textured to moderately fine textured glacial till.

In a typical profile the surface layer, about 10 inches thick, consists of very dark brown, noncalcareous loam. The next layer, about 10 inches thick, consists of light-gray loam that has coarse, angular blocky structure. It is very strongly calcareous and has a few lime concretions. Below this is light yellowish-brown clay loam. The upper part has weak, coarse, angular blocky structure and is strongly calcareous. The lower part is massive. It contains distinct mottles of gray and strong brown and prominent clusters of gypsum crystals.

Permeability is moderate in the surface layer and upper part of the substratum, but it is moderately slow in the lower part. The moisture-holding capacity is high. The water table rises to within 2 to 3 feet of the surface in spring. These soils are well supplied with organic matter and plant nutrients, but they may be somewhat deficient in phosphorus. They have a high content of lime.

Most of the acreage is cultivated. Small grain, corn, flax, alfalfa, and other crops commonly grown in the Area are well suited.

Typical profile of Hamerly loam, about 0.5 mile east and 280 feet south of the NW. corner of sec. 29, T. 135 N., R. 60 W.

A1—0 to 10 inches, very dark brown (10YR 2/2) loam, black (10YR 2/1) when moist; moderate, coarse, prismatic structure breaking to moderate, fine, granular; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

C1ca—10 to 20 inches, light-gray (5Y 7/2) loam, olive (5Y 5/3) when moist; weak, coarse, angular blocky structure breaking to moderate, fine, angular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; few lime concretions; gradual, wavy boundary.

C2—20 to 27 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) when moist; weak, coarse, angular blocky structure breaking to moderate, fine, angular blocky; slightly hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; gradual, wavy boundary.

C3cs—27 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) when moist; many, medium and coarse, distinct mottles of gray (5Y 5/1, moist) and strong brown (7.5YR 5/8, moist); massive; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; many prominent clusters of gypsum crystals.

The surface layer ranges from 6 to 14 inches in thickness. The upper part is noncalcareous, except in areas where material has been brought upward through tillage. The lower part of the surface layer contains an accumulation of lime and is strongly to very strongly calcareous. The upper part of the C1ca horizon ranges from grayish brown to olive in color and from 6 to 20 inches in thickness. It contains a few gypsum crystals in some places. The lower part of the substratum is loam to clay loam glacial till. It is slightly to strongly calcareous and contains a few crystals of gypsum.

Hamerly soils have an accumulation of lime just below the surface layer, which is lacking in Barnes and Svea soils. They have fewer mottles in the substratum than Vallers soils and are better drained than those soils. They have a higher concentration of lime than Buse soils. Unlike the Glyndon soils, which developed in pebble-free deposits left by glacial melt water, Hamerly soils developed in glacial till.

Hamerly loam (0 to 2 percent slopes) (Hf).—This soil occurs on uplands as areas surrounding shallow depressions. Included in mapping were areas, less than 2 acres in size, of Svea and Tonka soils.

This soil is calcareous. It has the profile described as typical of the series.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are well suited. Spring planting is sometimes delayed because of a perched water table. This soil is moderately susceptible to wind erosion, especially in areas where material from the limy subsoil has been mixed with material from the surface layer in cultivation. The high content of lime causes the soil to slake down into sand-sized particles that blow readily. Management practices are needed to control erosion, improve subsurface drainage, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, establishing windbreaks, inclusion of deep-rooted legumes in the cropping system, application of manure, and fertilizing. Trees are well suited. (Capability unit IIe–4L; Silty range site; windbreak site 1)

Hamerly-Svea loams (0 to 5 percent slopes) (Hg).—This complex occurs on glaciated uplands, mainly in the northeastern part of La Moure County. Hamerly loam makes up about 60 percent of the complex, and Svea loam about 30 percent. Barnes loam, Vallers silty clay loam, and Tonka silt loam make up the rest.

These soils have profiles like those described as typical of their respective series.

Most of the acreage is used for crops. Small grain, corn, flax, alfalfa, and other crops commonly grown in the Area are well suited. This complex is moderately susceptible to erosion because of the high percentage of Hamerly soils. In areas where the limy material of the Hamerly soil has been brought upward, the surface layer slakes down readily into sand-sized particles that blow easily. Management practices are needed to control erosion and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, establishing windbreaks, frequent inclusion of legumes and grasses in the cropping system, application of manure, and fertilizing. Trees are well suited. (Capability unit IIe–4L; Silty range site; windbreak site 1)

Hecla Series

The Hecla series consists of deep, moderately well drained, nearly level to gently undulating soils on sandy lake plains and on sandy uplands and terraces in the James River Valley. These soils formed in coarse-textured deposits left by glacial melt water and reworked by wind.

In a typical profile the surface layer, about 6 inches thick, consists of dark-gray fine sandy loam. The subsurface layer, about 12 inches thick, consists of dark-gray, very friable fine sandy loam that has very coarse, pris-

matic structure. The subsoil, about 10 inches thick, consists of dark grayish-brown and grayish-brown loamy fine sand that has weak, coarse, blocky structure. The underlying material consists of light brownish-gray and brown fine sand. This material is mottled below a depth of about 42 inches.

Permeability is moderately rapid, and the moisture-holding capacity is moderate. These soils are highly susceptible to wind erosion. They have a moderately high organic-matter content.

Most of the acreage is cultivated, but some is used for native pasture and hay. The soils are fairly well suited to crops, especially in years when rainfall is evenly distributed throughout the growing season.

Typical profile of Hecla fine sandy loam in a cultivated field, 80 feet north and 0.3 mile west of the SE. corner of sec. 29, T. 130 N., R. 59 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; weak, medium, blocky and granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; abundant roots; abrupt, smooth boundary; sodium adsorption ratio 0.4.

A1—6 to 18 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; very coarse, prismatic structure breaking to weak, coarse, blocky; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary; sodium adsorption ratio 0.4.

B21—18 to 24 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark brown (10YR 2/2) when moist; weak, coarse, blocky structure; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; plentiful roots; clear, wavy boundary; sodium adsorption ratio 0.5.

B22—24 to 28 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, coarse, blocky structure; soft to loose when dry, very friable to loose when moist, slightly sticky and nonplastic when wet; plentiful roots; clear, wavy boundary; sodium adsorption ratio 0.5.

C1—28 to 42 inches, light brownish-gray (2.5Y 6/2) fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; few roots; clear, smooth boundary; sodium adsorption ratio 0.6.

C2—42 to 60 inches, mottled, brown and light brownish-gray (10YR 5/3 and 2.5Y 6/2) fine sand, dark brown and grayish brown (10YR 3/3 and 2.5Y 5/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; sodium adsorption ratio 0.6.

The surface layer ranges from 14 to 30 inches in thickness and from fine sandy loam to fine sand in texture. The subsoil ranges from 4 to 16 inches in thickness, from loamy fine sand to fine sand in texture, and from very dark brown to very dark grayish brown in color. Faint, brown mottles occur in the subsoil in places. The substratum is dark grayish-brown to light olive-brown loamy fine sand to sand. Mottles are common. In some places there is a layer of very fine sandy loam, silt loam, or silty clay loam in the substratum at a depth below about 40 inches. Loam to clay loam glacial till occurs below a depth of about 3 feet in places. The depth to lime ranges from 30 inches to more than 5 feet.

Hecla soils have a thicker surface layer than Maddock soils. They are coarser textured than Embden soils, and they are better drained and have fewer mottles than Hamar soils. Unlike Ulen soils, they lack an accumulation of lime just below the surface layer.

Hecla fine sandy loam (0 to 2 percent slopes) (Hh).—This soil occurs on sandy lake plains and on terraces in the James River Valley. Included in mapping were areas, less than 2 acres in size, of a Maddock fine sandy loam, Hamar fine sandy loam, Embden fine sandy loam, and Ulen fine sandy loam.

This soil has the profile described as typical of the series. The moisture-holding capacity is low, and the soils are highly susceptible to wind erosion.

Most of the acreage is cultivated, but some areas are used for pasture and hay. Small grain, corn, flax, alfalfa, and other crops grown in this Area are fairly well suited. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 1)

Hecla fine sandy loam, silty substratum (0 to 2 percent slopes) (Hk).—This soil occurs on sandy lake plains. Included in mapping were areas, less than 2 acres in size, of a Maddock fine sandy loam, Hamar fine sandy loam, Embden fine sandy loam, and Ulen fine sandy loam.

This soil has a profile like that described as typical of the series, except that there is a layer of silt loam or silty clay loam at a depth of about 40 inches. Permeability is rapid above this layer; then it is moderately slow.

Most of the acreage is cultivated, but some is used for pasture and hay. Small grain, corn, flax, and alfalfa are the main crops. This soil is highly susceptible to wind erosion if cultivated and not protected. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 1)

Hecla loamy fine sand (0 to 2 percent slopes) (Hl).—This soil occurs on sandy lake plains and on sandy uplands. Included in mapping were areas, less than 2 acres in size, of a Maddock loamy fine sand, Hecla fine sandy loam, Ulen fine sandy loam, and Hamar fine sandy loam.

This soil has a profile similar to that described as typical of the series, except that the surface layer is loamy fine sand.

Most of the acreage is cultivated, but some fairly large areas are used for hay and pasture (fig. 6). Small grain, corn, and alfalfa are the main crops. This soil is highly susceptible to wind erosion. Management practices are needed to control wind erosion, conserve moisture, and maintain the organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe-2; Sandy range site; windbreak site 1)

Hecla loamy fine sand, gently undulating (3 to 5 percent slopes) (HlB).—This soil occurs on sandy lake plains. Most areas have been reworked by wind, and in many small areas the original surface layer has been blown away and redeposited as small hummocks. The surface layer of the hummocks is lighter colored than the original surface layer because it contains less organic matter. Included in mapping were areas, less than 2 acres

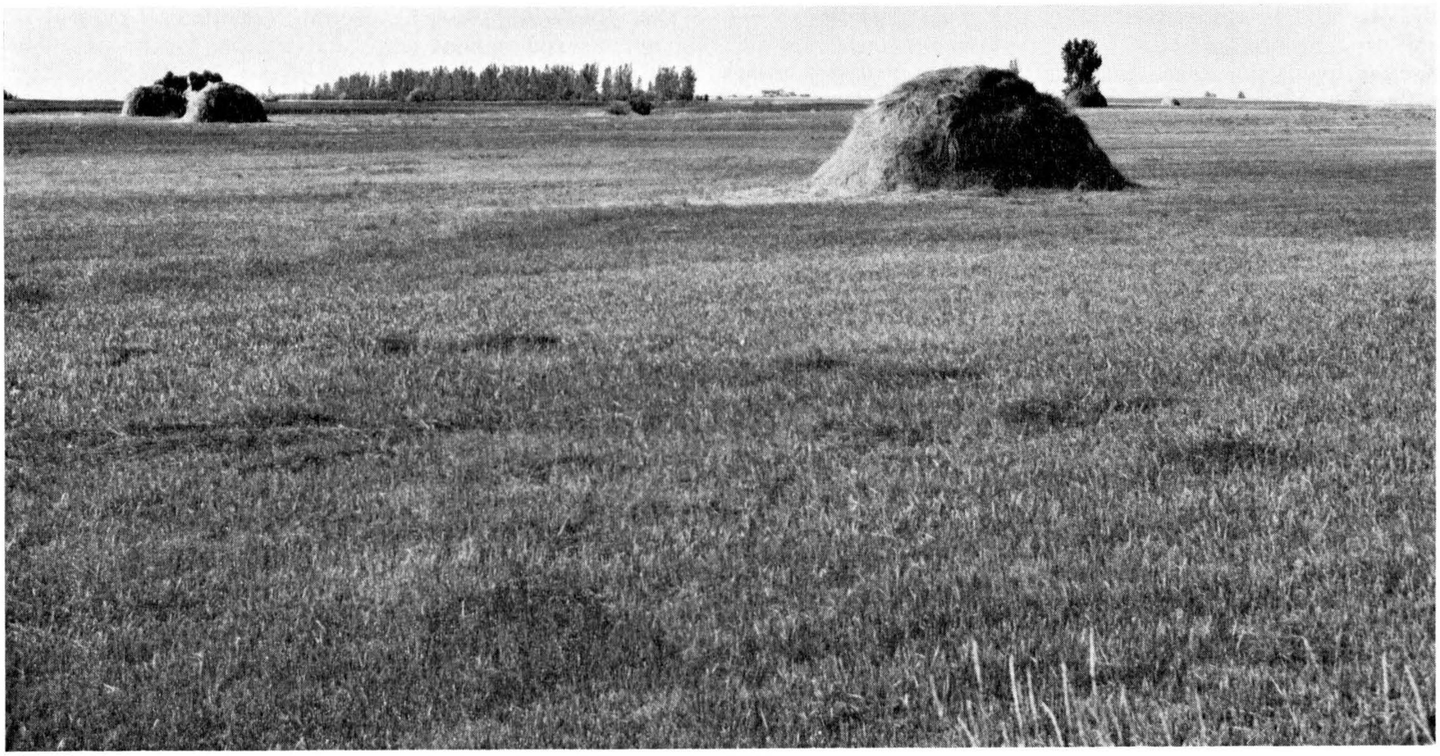

Figure 6.—Hay on Hecla loamy fine sand. This sandy soil is highly susceptible to wind erosion if cultivated.

in size, of Hecla fine sandy loam, a Maddock loamy fine sand, Hamar fine sandy loam, and a Ulen loamy fine sand.

This soil has a profile like that described as typical of the series, except that the surface layer is loamy fine sand.

Most of the acreage is used for hay and pasture, but some areas are cultivated. This soil is highly susceptible to wind erosion, and it has low moisture-holding capacity. Management practices are needed to control wind erosion, conserve moisture, and maintain the organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; windbreak site 1)

Hecla loamy fine sand, silty substratum (0 to 2 percent slopes) (Hm).—This soil occurs on sandy lake plains. Included in mapping were areas, less than 2 acres in size, of a Maddock loamy fine sand, Hecla fine sandy loam, Hamar fine sandy loam, and a Ulen loamy fine sand.

This soil has a profile like that described as typical of the series, except that the surface layer is loamy fine sand, and there is a layer of silt loam or silty clay loam at a depth of about 40 inches. Permeability is rapid above this layer, and then it is moderately slow.

Most of the acreage is cultivated, but some areas are used for hay and pasture. Small grain, corn, and alfalfa are the main crops. This soil is highly susceptible to wind erosion. Management practices are needed to control wind erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; windbreak site 1)

Hecla-Hamar complex (0 to 2 percent slopes) (Hn).—This complex occurs as nearly level areas and slight depressions on sandy lake plains. Hecla fine sandy loam makes up about 50 percent of the acreage, and Hamar loamy fine sand about 40 percent. The rest consists of Maddock loamy fine sand, Ulen fine sandy loam, and Hecla loamy fine sand. The Hecla soil is in the higher positions on the landscape, and the Hamar soil is in the shallow dips and depressions.

These soils have profiles like the ones described as typical of their respective series. In some small areas there is a layer of silt loam or silty clay loam at a depth of about 40 inches. The Hecla soil is moderately well drained, but the Hamar soil has a water table that rises to within 2 feet of the surface after rapid snowmelt or heavy rainfall.

Most of the acreage is cultivated, but some is used for hay and pasture. Small grain, corn, and alfalfa are the main crops. These soils are highly susceptible to wind erosion. Management practices are needed to control erosion and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. On the Hamar soil, spring planting must be delayed at times because of wetness. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; Hecla part is in windbreak site 1; Hamar part is in windbreak site 7)

Hecla-Hamar loamy fine sands, level (0 to 2 percent slopes) (HoA).—This complex occurs as nearly level areas

and slight depressions on sandy lake plains. Hecla loamy fine sand makes up about 50 percent of the acreage, and Hamar loamy fine sand about 40 percent. The rest consists of a Maddock loamy fine sand and a Ulen loamy fine sand. The Hecla soil is in the higher positions on the landscape, and the Hamar soil is in the shallow dips and depressions.

The Hecla soil has the profile described as typical of the series, except that the surface layer is sandier. It is moderately well drained. The Hamar soil has the profile described as typical of the series. The water table in this soil rises to within 2 feet of the surface after rapid snowmelt or heavy rainfall. Wind erosion is a severe hazard. There are many small blowouts scattered throughout the areas.

Most of the acreage is cultivated, but some is used for hay and pasture. Small grain, corn, and alfalfa are the main crops. Management practices are needed to control wind erosion, conserve moisture, and maintain the organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; Hecla part is in windbreak site 1; Hamar part is in windbreak site 7)

Hecla-Hamar loamy fine sands, gently undulating (3 to 5 percent slopes) (HoB).—This complex occurs on sandy lake plains. Hecla loamy fine sand makes up about 45 percent of the complex, and Hamar loamy fine sand about 35 percent. The rest consists of small areas of a Maddock loamy fine sand, a Ulen loamy fine sand, Arveson fine sandy loam, and Tiffany fine sandy loam. Most areas of this complex have been reworked by wind, and there are many low hummocks or dunes and intervening shallow depressions.

The Hecla soil has the profile described as typical of the series, except that the surface layer is sandier. It is moderately well drained. The Hamar soil has the profile described as typical of the series. The water table in this soil rises to within 2 feet of the surface after rapid snowmelt or heavy rainfall.

These soils are highly susceptible to wind erosion, and in some areas the surface layer has been blown away and redeposited as small dunes. In these places the surface layer is lighter colored than the original surface layer because it contains less organic matter.

Most of the acreage is used for hay and pasture, but some of it is cultivated. Small grain, corn, and alfalfa are the main crops. Management practices are needed to control wind erosion, conserve moisture, and restore fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; Hecla part is in windbreak site 1; Hamar part is in windbreak site 7)

Hecla-Ulen complex, level (0 to 2 percent slopes) (HuA).—This complex occurs on sandy lake plains. Hecla loamy fine sand makes up about 45 percent of the complex, and Ulen fine sandy loam about 35 percent. The rest consists of a Maddock loamy fine sand, Hamar loamy fine sand, Arveson fine sandy loam, and Hecla fine sandy loam.

The Hecla soil has the profile described as typical of the series, except that the surface layer is sandier. The Ulen soil has the profile described as typical. The water table in this soil rises to within 2 feet of the surface after rapid snowmelt or heavy rainfall. In some small areas there is a layer of silt loam or silty clay loam at a depth of about 40 inches.

Most of the acreage is used for hay and pasture, but some areas are cultivated. Wind erosion is a severe hazard. Management practices are needed to control wind erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; Hecla part is in windbreak site 1; Ulen part is in windbreak site 7)

Hecla-Ulen complex, gently undulating (3 to 5 percent slopes) (HuB).—This complex occurs on sandy lake plains. Hecla loamy fine sand makes up about 45 percent of the complex, and Ulen fine sandy loam makes up about 35 percent. The rest consists of a Maddock loamy fine sand, Hamar loamy fine sand, Arveson fine sandy loam, and Hecla fine sandy loam.

The Hecla soil has the profile described as typical of the series, except that the surface layer is sandier. The Ulen soil has the profile described as typical of the series. The water table in this soil rises to within 2 feet of the surface after rapid snowmelt or heavy rainfall.

Most of this complex has been reworked by wind, and there are many small blowouts and low hummocks and dunes. The soils are highly susceptible to wind erosion, and in some areas the surface layer has been blown away and redeposited in other places to a depth of as much as 12 inches. This windblown material is lighter colored than the original surface layer because it contains less organic matter.

Most of the acreage is used for pasture and hay, but some small areas are cultivated. Management practices are needed to control wind erosion, conserve moisture, maintain the organic-matter content, and restore fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, frequent inclusion of grass in the cropping system, drill seeding, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; windbreak site 1)

Hecla-Ulen fine sandy loams (0 to 2 percent slopes) (Hv).—This complex occurs on sandy lake plains. Hecla fine sandy loam makes up about 50 percent of the complex, and Ulen loamy fine sand 40 percent. The rest consists of a Maddock loamy fine sand, Hamar loamy fine sand, and Hecla loamy fine sand.

These soils have profiles like the ones described as typical of their respective series. In some areas there is a layer of very fine sandy loam, silt loam, or silty clay loam at a depth of about 40 inches. Permeability is slow in this layer, and the moisture-holding capacity is higher than in other areas of this complex.

Most of the acreage is cultivated, but some areas are used for pasture and hay. Small grain, corn, flax, and alfalfa are the main crops. These soils are highly susceptible to wind erosion, and management practices are

needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; windbreak site 1)

Hegne Series

The Hegne series consists of poorly drained, calcareous soils on plains and lacustrine flats. These soils formed in fine-textured lacustrine sediments.

In a typical profile the surface layer, about 8 inches thick, consists of very dark gray, slightly calcareous silty clay. The subsurface layer, about 13 inches thick, consists of dark-gray silty clay that has moderate, coarse, prismatic structure. It contains a few lime concretions. The underlying material consists of light olive-gray to gray silty clay that grades to silty clay loam at a depth of about 54 inches. It has strong, medium, angular blocky structure to a depth of 32 inches, but it is massive below a depth of 40 inches. The soil material between 8 inches and 40 inches is strongly calcareous; below that depth, the material is slightly calcareous.

Permeability is slow, and the moisture-holding capacity is high. The content of organic matter is good. The water table is within 5 feet of the surface most of the year and is at or near the surface in spring.

Most of the acreage is cultivated along with adjoining Fargo soils. Small grain is the main crop.

Typical profile of Hegne silty clay in a cultivated field, about 0.45 mile west and 120 feet north of the SE. corner of sec. 23, T. 133 N., R. 66 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate, coarse, prismatic structure breaking to strong, fine, angular blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous; clear, irregular boundary.

A1ca—8 to 21 inches, dark-gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) when moist; moderate, coarse, prismatic structure breaking to moderate, medium and coarse, subangular blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; few lime concretions; gradual, wavy boundary.

C1ca—21 to 32 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 5/2) when moist; strong, medium, angular blocky structure breaking to moderate, very fine, angular blocky; very hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; gradual, wavy boundary.

C2cag—32 to 40 inches, gray (5Y 6/1) silty clay, gray (5Y 5/1) when moist; many, fine, faint mottles of olive brown (2.5Y 4/4, moist) and olive yellow (2.5Y 6/6, moist); strong, medium, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; many lime concretions; gradual, wavy boundary.

C3csg—40 to 54 inches, gray (5Y 6/1) silty clay, gray (5Y 5/1) when moist; many, medium and coarse, prominent mottles of reddish brown (5YR 4/4, moist) and olive yellow 2.5Y 6/6, moist); massive; very hard when dry, very firm when moist, very sticky and very plastic when wet; slightly calcareous; few lime concretions and many distinct clusters of gypsum crystals; gradual, wavy boundary.

C4g—54 to 60 inches, gray (5Y 6/1) silty clay loam, gray (5Y 5/1) when moist; many, medium and coarse, prominent mottles of reddish brown (5YR 4/4, moist) and olive yellow (2.5Y 6/6, moist); massive; very hard when dry, very firm when moist, sticky and plastic when wet; slightly calcareous.

The surface layer ranges from 6 to 14 inches in thickness. The subsurface layer ranges from very dark gray to gray in color and from 10 to 20 inches in thickness. Sand and gravel occur below a depth of 2 feet in some places in the James River Valley.

Hegne soils have a concentration of lime below the surface layer, which is lacking in Fargo soils. They are better drained and have fewer mottles than Grano soils. Hegne soils are finer textured than Bearden soils.

Hegne-Fargo complex, sandy substrata (0 to 2 percent slopes) (Hx).—This complex occurs in the James River Valley. Hegne silty clay makes up about 60 percent of the complex, and Fargo silty clay about 40 percent. These soils formed in fine-textured lacustrine sediments. They are poorly drained.

These soils have profiles like the ones described as typical of their respective series, except that they are underlain by coarse sand and gravel at a depth of about 3 feet. Permeability is slow above the sandy layer; then it is rapid. The water table is seasonally high, and flooding occurs at times.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are well suited. Surface drainage is needed to remove excess water. These soils are moderately susceptible to wind erosion when they are fall plowed because the clay surface layer slakes down into sand-sized particles that blow easily. Stubble-mulch tillage, management of crop residue, frequent inclusion of deep-rooted legumes in the cropping system, establishing windbreaks, and fertilizing are beneficial. Trees are well suited. (Capability unit IIwe–4; Clayey range site; windbreak site 1)

LaDelle Series

The LaDelle series consists of deep, dark-colored, moderately well drained, nearly level soils on low terraces, levees, and alluvial fans in the James River Valley. These soils formed in medium-textured to moderately fine textured alluvium.

In a typical profile the surface layer, about 10 inches thick, consists of black silt loam. The subsoil, about 10 inches thick, consists of very dark brown, friable silt loam that has moderate, medium, prismatic and blocky structure. The lower part contains a small amount of segregated lime. The underlying material consists of mottled, very dark grayish-brown to dark grayish-brown, calcareous silt loam to silty clay loam.

Permeability is moderate to moderately slow, and the moisture-holding capacity is high. These soils are well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are well suited.

Typical profile of LaDelle silt loam in a cultivated field, about 1,000 feet east and 75 feet north of the SW. corner of sec. 35, T. 134 N., R. 61 W.

Ap—0 to 10 inches, black (10YR 2/1 , moist) silt loam; weak to moderate, fine, crumb structure; friable when moist, slightly stickly and slightly plastic when wet; clear, smooth boundary.

B2—10 to 20 inches, very dark brown (10YR 2/2, moist) silt loam; moderate, medium, prismatic and blocky structure; friable when moist, slightly sticky and slightly plastic when wet; a small amount of segregated lime in lower part; clear boundary.

C1—20 to 36 inches, very dark grayish-brown (10YR 3/2, moist) silt loam; many, fine, faint, dark yellowish-brown (10YR 4/4, moist) mottles; weak, coarse, prismatic structure; friable when moist, slightly sticky and slightly plastic when wet; calcareous; many fine segregations of lime; clear boundary.

C2—36 to 50 inches, dark grayish-brown (2.5Y 4/2, moist) silt loam; friable when moist, slightly sticky and slightly plastic when wet; calcareous; clear boundary.

C3—50 to 60 inches, dark grayish-brown (2.5Y 4/2, moist) silty clay loam; few, small, distinct, dark-olive (5Y 3/4, moist) mottles; friable when moist, sticky and plastic when wet; calcareous; many lime segregations.

The surface layer ranges from silt loam to silty clay loam in texture and from 8 to 18 inches in thickness. The texture of the subsoil ranges from silt loam to silty clay loam. In some profiles the subsoil is slightly calcareous. The texture of the underlying material ranges from loam to silty clay loam, but in some places silty clay occurs at a depth of about 30 inches.

LaDelle soils have stronger structural development in the subsoil than LaPrairie soils. They have fewer mottles and less lime than Lamoure soils. Their profile is darker colored to a greater depth than that of Gardena and Overly soils.

LaDelle silt loam (0 to 2 percent slopes) (La).—This soil occurs on low terraces and alluvial fans in the James River Valley. Included in mapping were areas, less than 2 acres in size, of Gardena loam, LaPrairie silt loam, and Lamoure silty clay loam.

This soil has the profile described as typical of the series. Permeability is moderate and moderately slow, and the moisture-holding capacity is high.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Management practices are needed to conserve moisture and maintain fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial. Trees are well suited. (Capability unit IIc–6; Silty range site; windbreak site 1)

LaDelle silty clay loam (0 to 2 percent slopes) (Lc).—This soil occurs on low terraces and levees in the James River Valley. Included in mapping were areas, less than 2 acres in size, of Lamoure silty clay loam and LaPrairie silt loam.

This soil has a profile like that described as typical of the series, except that the surface layer and subsoil are silty clay loam, rather than silt loam. Permeability is moderately slow, and the moisture-holding capacity is high. This soil is well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are well suited. Management practices are needed to conserve moisture and maintain fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial. Trees are well suited. (Capability unit IIc–6; Clayey range site; windbreak site 1)

LaDelle soils, clayey substratum (0 to 2 percent slopes) (Ld).—These soils occur on low terraces in the James River Valley. The texture of the surface layer is silt loam in most places, but in some areas it is silty clay loam.

These soils have the profile described as typical of the series, except that there is a layer of silty clay at a depth of about 30 inches. Permeability is moderate or moderately slow above the clay substratum; then it is slow. The moisture-holding capacity is high.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. The main problems in management are conservation of moisture and maintenance of fertility. Stubble-mulch tillage, management of crop residue, and fertilizing are beneficial. Trees are well suited. (Capability unit IIc–6; Silty range site; windbreak site 1)

Lamoure Series

The Lamoure series consists of deep, poorly drained soils on bottom lands. These soils formed in medium-textured to moderately fine textured alluvium.

In a typical profile the surface layer, about 10 inches thick, consists of very dark gray silty clay loam. Below this is grayish-brown, friable, strongly calcareous silty clay loam, about 24 inches thick, that has weak, coarse and medium, blocky structure or is massive. The underlying material consists of light-gray to light brownish-gray, strongly calcareous silty clay loam to fine sandy loam.

Permeability is moderately slow. The water table is within 5 feet of the surface most of the year and at or near the surface in spring. Some areas are subject to flooding.

Lamoure soils are used mainly for hay and pasture, but some of the better drained areas are cultivated. The soil is usually too wet to be cultivated early in spring. Small grain, corn, flax, and millet, which can be planted late in the season, are suitable crops.

Typical profile of Lamoure silty clay loam in a cultivated field, 500 feet south and 1,300 feet west of the center of sec. 17, T. 131 N., R. 59 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium, blocky and granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; abrupt, smooth boundary.

A11—6 to 10 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium, blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; slightly calcareous; clear, smooth boundary.

A12ca—10 to 34 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark gray (10YR 3/1) when moist; weak, coarse and medium, blocky structure or massive; slightly hard when dry, friable when moist, sticky and plastic when wet; many, fine, distinct lime segregations; strongly calcareous; clear, smooth boundary.

C1ca—34 to 46 inches, light-gray (2.5Y 7/0) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium, blocky structure; hard when dry, firm when moist, sticky and plastic when wet; many, fine, distinct lime segregations; strongly calcareous; clear, wavy boundary.

C2ca—46 to 60 inches, light brownish-gray (2.5Y 6/2) and light-gray to gray (5Y 6/1) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

The texture of the surface layer ranges from silt loam to silty clay loam, and the thickness from 8 to 20 inches. The A12 horizon ranges from grayish brown to very dark gray in color. It is mildly alkaline to moderately alkaline. It ranges from silty clay loam to silt loam in texture and from 10 to 30 inches in thickness. The substratum ranges from very dark grayish brown to light olive gray. It is mildly alkaline to moderately

alkaline. Coarse sand and gravel occur below a depth of 36 inches in some places. Gypsum and other salts occur throughout the profile in some areas.

Lamoure silty clay loam (0 to 2 percent slopes) (Le).—This soil occurs on bottom lands. Included in mapping were small areas of LaPrairie silt loam and Rauville soils.

This soil has the profile described as typical of the series. In most places the surface layer is silty clay loam, but in some areas it is silt loam. This soil has a high water table and is subject to flooding.

Undrained areas are generally too wet to be cultivated. They are used mainly for hay and pasture. Corn, flax, millet, and small grain, which can be seeded late in the season, are suitable cultivated crops. Drained areas can be used for trees, but undrained areas are poorly suited. (Capability unit IIw-4L; Subirrigated range site; windbreak site 8)

Lamoure silty clay loam, saline (0 to 2 percent slopes) (Lf).—This soil occurs on bottom lands along the James River. It has the profile described as typical of the series, except that there is enough salt in the surface and subsurface layers to affect plant growth.

The water table is high, and the soil is subject to occasional flooding.

Most of the acreage is used for hay and pasture. Undrained areas are poorly suited to cultivated crops. If the soil is cultivated, salt-tolerant crops, such as barley, rye, oats, alfalfa, and sweetclover, are suitable. Frequent inclusion of deep-rooted legumes in the cropping system helps to lower the water table and leach salts from the surface layer. Trees are poorly suited. (Capability unit IIIws-4; Saline Subirrigated range site; windbreak site 8)

LaPrairie Series

The LaPrairie series consists of deep, moderately well drained, nearly level soils on bottom lands, terraces, and levees in the James River Valley. These soils developed in medium-textured alluvium.

In a typical profile the surface layer, about 9 inches thick, consists of very dark gray, noncalcareous silt loam. The next layer, about 21 inches thick, consists of dark-gray, friable, slightly calcareous silt loam that has weak, coarse, subangular blocky structure. Below this is dark-gray, calcareous silt loam about 26 inches thick. The underlying material consists of grayish-brown, strongly calcareous loam.

Permeability is moderate, and the moisture-holding capacity is high. These soils are well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are suitable crops. Areas that are highly dissected by stream channels are used mainly for native grasses. Some of the channeled areas in the James River Valley are wooded.

Profile of LaPrairie silt loam, about 1,050 feet south and 250 feet west of the NE. corner of sec. 36, T. 133 N., R. 61 W.

A11—0 to 9 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, fine, crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; gradual, smooth boundary.

A12—9 to 30 inches, dark-gray (10YR 4/1) silt loam; very dark gray (10YR 3/1) when moist; weak, coarse, subangular blocky structure breaking to moderate, fine, granular; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; gradual, smooth boundary.

A13—30 to 56 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; calcareous; gradual, smooth boundary.

C—56 to 60 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

The surface layer ranges from very fine sandy loam to silt loam in texture. It is noncalcareous to weakly calcareous. In places the material below the surface layer contains thin layers that range from fine sand to clay in texture. This material is weakly to strongly calcareous. The substratum ranges from silt loam to sand in texture. It is weakly to strongly calcareous. Sand and gravel occur at a depth below 3 feet in some places.

LaPrairie soils have weaker structural development in the subsurface material than LaDelle soils. They are better drained and have fewer mottles than Lamoure soils.

LaPrairie silt loam (0 to 3 percent slopes) (Lg).—This soil occurs on bottom lands, low terraces, and levees. Included in mapping were small areas of LaDelle silt loam and Lamoure silty clay loam.

This soil has the profile described as typical of the series. In most places the surface layer is silt loam, but in some small areas the surface layer is loam or very fine sandy loam.

Most of the acreage is cultivated. All the crops commonly grown in the Area are well suited. The main management problems are conservation of moisture and maintenance of fertility. Erosion is not a problem. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial practices. Trees are well suited. (Capability unit IIc-6; Silty range site; windbreak site 1)

LaPrairie silt loam, channeled (0 to 3 percent slopes) (Ll).—This soil occurs on bottom lands, terraces, and levees in the James River Valley. The areas are dissected by shallow channels and oxbow lakes. Included in mapping were small areas of LaDelle silt loam and Lamoure silty clay loam. In most places the surface layer is silt loam, but in some areas it is loam or very fine sandy loam.

Most of the acreage is cultivated, but some small areas are used for pasture or woodland. Small grain, corn, flax, and alfalfa are well suited. Management practices are needed to conserve moisture, control water erosion, and maintain fertility. Stubble-mulch tillage, management of crop residue, and fertilizing are beneficial. Trees are well suited. (Capability unit IIe-6; Silty range site; windbreak site 1)

LaPrairie and Lamoure soils, channeled (0 to 3 percent slopes) (Lm).—This undifferentiated unit occurs on bottom lands that are highly dissected by meandering channels and oxbows. It generally occurs as long, narrow areas along tributaries of the James River. LaPrairie silt loam makes up about 65 to 75 percent of the acreage, and Lamoure silty clay loam makes up the rest. The LaPrairie soil is on the higher positions on bottom lands and levees, and the Lamoure soil is in the channels.

These soils have profiles like those described as typical of their respective series. The La Prairie soil is moderately

well drained, and the Lamoure soil is poorly drained.

These soils are not suitable for cultivation, because the numerous channels and oxbows are not crossable with farm machinery. Nearly all the acreage is used for native pasture or hay. A few acres in the James River Valley are wooded. The native vegetation consists mainly of green needlegrass, bearded wheatgrass, western wheatgrass, big bluestem, switchgrass, and slender wheatgrass. These soils produce good-quality forage when properly managed. Trees are well suited. (Capability unit VIe–Si; Silty range site; LaPrairie part is in windbreak site 1; Lamoure part is in windbreak site 8)

Letcher Series

The Letcher series consists of somewhat poorly drained, alkali soils. These soils occur as nearly level areas and slight depressions on lake plains. They formed in moderately coarse textured deposits left by glacial melt water.

In a typical profile the surface layer, about 8 inches thick, consists of dark-gray, moderately alkaline fine sandy loam. The upper part of the subsoil consists of grayish-brown to pale-brown fine sandy loam that has strong, medium, columnar structure. The lower part consists of light-gray fine sandy loam and sandy clay loam that has moderate, coarse, columnar and prismatic structure. Below this is light-gray to light brownish-gray fine sandy loam that is strongly calcareous to slightly calcareous.

Permeability is moderate to moderately rapid in the surface layer, but it is slow in the subsoil. The moisture-holding capacity is low. The density of the subsoil and the high content of soluble salts in the subsoil and substratum limit root penetration. A perched water table, just above the subsoil, occurs during periods of heavy rainfall. The water table is high in spring, and tillage is often delayed because of wetness.

Most of the acreage is in hay or pasture, although some areas are cultivated.

Typical profile of Letcher fine sandy loam in a cultivated field, 500 feet north and 400 feet west of the SE. corner of sec. 19, T. 130 N., R. 59 W.

Ap—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; weak, medium, blocky and granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; abundant roots; abrupt, smooth boundary; sodium adsorption ratio 21.0.

B21—8 to 14 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; thick, black (10YR 2/1, moist) continuous clay skins on ped faces; strong, medium, columnar structure breaking to strong, medium, blocky; hard when dry, firm when moist, slightly sticky and plastic when wet; few roots; clear, wavy boundary; sodium adsorption ratio 71.1.

B22—14 to 18 inches, pale-brown (10YR 6/3) fine sandy loam, grayish brown (10YR 5/2) when moist; grayish-brown (10YR 5/2) patchy clay skins on ped faces; strong, medium, columnar structure breaking to strong, medium, blocky; hard when dry, firm when moist, slightly sticky and plastic when wet; very few roots; clear, wavy boundary; sodium adsorption ratio 192.4.

B23ca—18 to 28 inches, light-gray (2.5Y 7/2) fine sandy loam and sandy clay loam, grayish brown (2.5Y 5/2) when moist; moderate, coarse, columnar and prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; very strongly calcareous; clear, smooth boundary; sodium adsorption ratio 288.0.

C1ca—28 to 36 inches, light-gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) when moist; moderate, medium, blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many, medium, distinct segregations of lime; strongly calcareous; clear, smooth boundary; sodium adsorption ratio 284.3.

C2—36 to 42 inches, light-gray (2.5Y 7/2) fine sandy loam, grayish brown (2.5Y 5/2) when moist; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; clear, smooth boundary; sodium adsorption ratio 192.0.

C3—42 to 54 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/6) mottles and common, medium, prominent, black (10YR 2/1, moist and dry) mottles; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; clear, smooth boundary; sodium adsorption ratio 131.3.

C4—54 to 60 inches, light-gray (5Y 7/2) fine sandy loam, olive gray (5Y 5/2) when moist; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; sodium adsorption ratio 128.0.

The surface layer ranges from 5 to 10 inches in thickness. A thin, dark-gray, platy subsurface layer occurs above the subsoil in areas where this soil has not been cultivated. The subsoil ranges from very dark grayish brown to light gray and pale brown in color and from 10 to 20 inches in thickness. The structure ranges from strong columnar in the upper part to moderate columnar and prismatic in the lower part. Clay films are continuous in the upper part of the subsoil but become patchy with depth. Clear sand grains occur on the top and along the sides of the columns. The interiors of the peds are calcareous. Crystals of soluble salts and gypsum are common in the subsoil and substratum. The substratum is mottled and is grayish brown to olive gray in color. The texture ranges from fine sandy loam in the upper part to fine sand in the lower part. In most places the upper part of the substratum contains an accumulation of lime.

Letcher soils developed in coarser textured sediments than Aberdeen and Exline soils. They developed in deposits left by glacial melt water, rather than in glacial till, which was the parent material of Cresbard and Cavour soils. Letcher soils have strong columnar structure in the subsoil, rather than strong prismatic structure, such as that of Stirum soils. They lack an accumulation of lime in the subsoil, which Stirum soils have.

Letcher fine sandy loam (0 to 2 percent slopes) (Ln).—This soil occurs as nearly level areas and slight depressions on sandy lake plains. Included in mapping were areas, less than 2 acres in size, of Stirum fine sandy loam, Ulen fine sandy loam, and Glyndon silt loam.

The claypan subsoil is slowly permeable, and it contains enough soluble salts to affect plant growth. This soil is highly susceptible to wind erosion when cultivated and not protected.

Most of the acreage is used for hay and pasture, but some areas are cultivated along with adjoining soils. The main considerations in management are control of erosion and improvement of subsurface drainage. Moderately salt tolerant crops should be grown. These include barley, rye, oats, wheat, millet, and alfalfa.

Stubble-mulching and management of crop residue are practices that help to control erosion. Frequent inclusion of deep-rooted legumes in the cropping system helps to lower the water table and improve permeability. Trees

are poorly suited. (Capability unit IIIe-3P; Sandy range site; windbreak site 8)

Loamy Lake Beaches

Loamy lake beaches (0 to 6 percent slopes) (Lo) consists of somewhat poorly drained, nearly level to sloping, moderately coarse textured to medium-textured soils. The soil material has a thin surface layer of sandy loam or loam. It is low in organic-matter content and plant nutrients and is susceptible to flooding. Some areas are moderately stony.

Most of the acreage is used for pasture, but some areas are cultivated. Small grain is the principal crop. Erosion is not a problem. Capability unit IVsw-6; Subirrigated range site; windbreak site 8)

Ludden Series

The Ludden series consists of deep, somewhat poorly drained to poorly drained soils. These soils occur as nearly level areas and slight depressions on bottom lands in the James River Valley, and they are subject to flooding. They formed in fine-textured alluvium.

In a typical profile the surface layer, about 13 inches thick, consists of dark-gray silty clay that is slightly calcareous. The next layer, about 11 inches thick, consists of dark-gray silty clay that is slightly to strongly calcareous. Below this is dark-gray to gray silty clay that contains lime and salt segregations and is slightly to strongly calcareous. Snail shells occur in the lower part.

Permeability is slow, and the moisture-holding capacity is high. Surface ponding is common during periods of heavy rainfall. The water table is high in spring, and in many years tillage must be delayed because of wetness.

Most of the acreage is cultivated, but some is used for hay and pasture. Small grain, corn, flax, and alfalfa are the main crops. Fall plowing is usually necessary if a suitable seedbed is to be prepared. The surface layer readily slakes down to sand-sized particles, however, and fall-plowed fields are susceptible to wind erosion. Surface drainage is needed to remove excess water.

Typical profile of Ludden silty clay in a cultivated field, 100 feet north and 100 feet east of the SW. corner of sec. 32, T. 131 N., R. 59 W.

Ap—0 to 5 inches, dark-gray (N 4/0) silty clay, black (10YR 2/1) when moist; moderate, medium, blocky and granular structure; very hard when dry, firm when moist, very sticky and very plastic when wet; abundant roots; slightly calcareous; lime segregations; abrupt, smooth boundary; sodium adsorption ratio 2.3.

A1—5 to 13 inches, dark-gray (N 4/0) silty clay, black (10YR 2/1) when moist; moderate, coarse, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; plentiful roots; slightly calcareous; few lime segregations; gradual, smooth boundary; sodium adsorption ratio 2.7.

AC—13 to 24 inches, dark-gray (N 4/0) silty clay, black (10YR 2/1) when moist; medium, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; few roots; slightly to strongly calcareous; lime and salt segregations; gradual, wavy boundary; sodium adsorption ratio 3.4.

C1—24 to 32 inches, dark-gray (N 4/0) silty clay, black (10YR 2/1) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; slightly to strongly calcareous; lime segregations and gypsum crystals; gradual, smooth boundary; sodium adsorption ratio 4.0.

C2—32 to 40 inches, dark-gray (N 4/0) silty clay, very dark gray (5Y 3/1) when moist; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; lime and salt segregations; gradual, smooth boundary; sodium adsorption ratio 4.2.

C3—40 to 62 inches, gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) when moist; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; lime and salt segregations; snail shells; sodium adsorption ratio 6.2.

The surface layer ranges from 10 to 36 inches in thickness. The underlying material ranges from very dark gray to olive gray in color. Olive-gray sandy loam occurs below a depth of 4 feet in some profiles. The entire profile is strongly calcareous in places, but more commonly, it is strongly calcareous below a depth of 30 inches. Crystals of soluble salts and gypsum are common below a depth of 30 inches, but they occur within 12 inches of the surface in some places.

Ludden soils developed in finer textured alluvium than Lamoure soils. They have fewer mottles and are not so poorly drained as Rauville soils. Their surface layer is thicker than that of Ryan soils, and their subsoil lacks columnar structure. They developed in alluvium, rather than in lacustrine sediments, which was the parent material of the Fargo soils, and they are dark colored to a greater depth than those soils.

Ludden silty clay (0 to 2 percent slopes) (Lu).—This soil occurs as nearly level areas and slight depressions on bottom lands in the James River Valley. Included in mapping were areas, less than 2 acres in size, of Ludden silty clay, saline; Ryan silty clay; and Lamoure silty clay loam.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated, but some is used for hay and pasture. Small grain, corn, flax, and alfalfa are suitable crops. Management practices are needed to maintain good tilth, provide adequate drainage, control erosion, and maintain fertility. Surface drainage, stubble-mulch tillage, management of crop residue, inclusion of deep-rooted legumes in the cropping system, and fertilizing are beneficial practices. Trees are well suited. (Capability unit IIwe-4; Clayey range site; windbreak site 1)

Ludden silty clay, saline (0 to 2 percent slopes) (Lw).—This soil occurs as nearly level areas and slight depressions on bottom lands in the James River Valley. Included in mapping were areas, less than 2 acres in size, of Ludden silty clay, Ryan silty clay, and Lamoure silty clay loam.

This soil has a profile like that described as typical of the series, except that it contains crystals of soluble salts in the surface layer and subsoil. The salt content is high enough to adversely affect plant growth.

Most of the acreage is used for pasture and hay, but some is cultivated. Management practices are needed to improve the subsurface drainage and maintain tilth and fertility. Moderately salt tolerant crops should be grown. These include barley, rye, oats, wheat, sweetclover, and alfalfa. Inclusion of deep-rooted legumes in the cropping system helps to lower the water table and reduce salt accumulation in the root zone. Other beneficial practices are application to manure, stubble-mulch tillage, management of crop residue, and fertilizing. Trees are poorly

suited. (Capability unit IIIs-4; Saline Subirrigated range site; windbreak site 8)

Ludden-Ryan silty clays (0 to 2 percent slopes) (Ly).—This complex occurs as nearly level areas and slight depressions on bottom lands in the James River Valley. Ludden silty clay makes up about 70 percent of the complex, and Ryan silty clay about 30 percent. Included in mapping were areas, less than 2 acres in size, of Ludden silty clay, saline, and Lamoure silty clay loam.

These soils have the profile described as typical of their respective series. The Ludden soils are deep, but the Ryan soils have a thin surface layer and a very slowly permeable claypan subsoil. The Ryan soils contain harmful quantities of salts in the subsoil. In cultivated areas the thin surface layer of the Ryan soil becomes mixed with the claypan subsoil and slick spots form. These spots are hard and cloddy when dry and sticky when wet.

Most of the acreage is used for hay and pasture, but some is cultivated. Small grain and alfalfa are the most suitable crops. Management practices are needed to improve permeability and tilth and to maintain fertility. Stubble-mulch tillage, management of crop residue, application of manure, inclusion of deep-rooted legumes in the cropping system, and fertilizing are beneficial practices. Trees are poorly suited. (Capability unit IIIs-4P; Saline Subirrigated range site; windbreak site 8)

Maddock Series

The Maddock series consists of deep, well-drained to somewhat excessively drained, nearly level to rolling soils on sandy lake plains and on sandy uplands and terraces in the James River Valley. These soils formed in coarse-textured deposits left by glacial melt water and in windblown sands.

In a typical profile the surface layer, about 8 inches thick, consists of dark-gray loamy fine sand. The subsoil, about 10 inches thick, consists of dark grayish-brown loamy fine sand that has weak, coarse, prismatic structure breaking to weak, medium, blocky. The underlying material is light grayish-brown to grayish-brown, very friable loamy fine sand that is slightly calcareous below a depth of 36 inches.

Permeability is rapid, and the moisture-holding capacity is moderate. These soils are highly susceptible to wind erosion.

Most of the acreage is cultivated, but some is used for hay and pasture. Management practices are needed to control erosion and maintain organic-matter content and fertility. Small grain, corn, flax, and alfalfa are suitable crops.

Typical profile of Maddock loamy fine sand in a cultivated field, 0.3 mile east and 0.15 mile north of the SW. corner of sec. 29, T. 130 N., R. 59 W.

Ap—0 to 8 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray to black (10YR 2.5/1) when moist; single grain; weak, medium, blocky structure; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; abundant roots; clear, smooth boundary; sodium adsorption ratio 0.4.

B—8 to 18 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, blocky; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; abundant roots; clear, wavy boundary; sodium adsorption ratio 0.5.

C1—18 to 36 inches, light grayish-brown to grayish-brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; very weak, coarse, prismatic structure breaking to very weak, medium, blocky structure and single grain; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; plentiful roots; gradual boundary; sodium adsorption ratio 0.3.

C2—36 to 50 inches, grayish-brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; single grain; soft to loose when dry, very friable to loose when moist, nonsticky and nonplastic when wet; few roots; slightly calcareous; gradual boundary; sodium adsorption ratio 0.3.

C3—50 to 60 inches, grayish-brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; single grain; soft to loose when dry, very friable to loose when moist, nonsticky and nonplastic when wet; slightly calcareous; sodium adsorption ratio 0.4.

The surface layer ranges from 4 to 14 inches in thickness, and the subsoil, from 6 to 16 inches. The underlying material is typically loamy fine sand or fine sand, but in some places glacial till occurs below a depth of 2 to 3 feet.

Maddock soils have a thinner surface layer than Hecla soils. They are coarser textured than Egeland soils. They are better drained than Ulen soils, and they lack the lime zone of those soils.

Maddock fine sandy loam, level (0 to 2 percent slopes) (MaA).—This soil occurs on sandy lake plains and on terraces in the James River Valley. Included in mapping were areas, less than 2 acres in size, of an Egeland fine sandy loam, Hecla fine sandy loam, Hamar fine sandy loam, and Ulen fine sandy loam.

This soil has a profile like that described as typical of the series, except that it has a surface layer of fine sandy loam. It takes in water readily, but it is droughty and highly susceptible to wind erosion. The moisture-holding capacity is low.

Most of the acreage is cultivated, but some areas are used for hay and pasture. Management practices are needed to control wind erosion, conserve moisture, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, including grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 4)

Maddock fine sandy loam, undulating (3 to 8 percent slopes) (MaB).—This soil occurs as gently sloping and undulating areas on sandy lake plains and on terraces in the James River Valley. Included in mapping were areas, less than 2 acres in size, of Hecla fine sandy loam, a Barnes loam, and a Maddock loamy fine sand.

This soil has a profile like that described as typical of the series, except that the surface layer consists of fine sandy loam that is about 4 to 6 inches thick on upper slopes and about 8 inches thick on lower slopes. Loam or clay loam glacial till occurs in the substratum below a depth of 2 or 3 feet in some places.

This soil takes in water readily, but it has moderate moisture-holding capacity. It is highly susceptible to wind erosion.

Most of the acreage is cultivated. Management practices are needed to control wind erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, wind strip-

cropping, establishing windbreaks, drill seeding, including grass in the cropping system, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe–3; Sandy range site; windbreak site 4)

Maddock and Barnes soils, rolling (3 to 15 percent slopes) (MbC).—This undifferentiated unit occurs on sand-mantled side slopes in the James River Valley. Maddock fine sandy loam makes up about 70 percent of the acreage, and Barnes loam makes up the rest. In about half the acreage the slope ranges from 9 to 12 percent. In some small areas the slope ranges from 3 to 5 percent, and in other places the slope is as much as 15 percent. Included in mapping were small areas of Hecla fine sandy loam.

The Maddock soil has a profile like that described as typical of the series, except that it has a surface layer of fine sandy loam and glacial till occurs in the substratum at a depth of about 2 to 3 feet. The Barnes soil has the profile described as typical of the Barnes series.

These soils are susceptible to water and wind erosion if cultivated. The moisture-holding capacity is moderately high because of the underlying till, but runoff is rapid.

Most of the acreage is used for hay and pasture, but some areas are cultivated. Small grain, flax, and alfalfa are better suited than other kinds of crops. Corn is not well suited because of the erosion hazard. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, contour tillage, frequent inclusion of grass in the cropping system, drill seeding, and fertilizing. (Capability unit IVe–3; Sandy range site; Maddock part is in windbreak site 4; Barnes part is in windbreak site 6)

Maddock and Hecla fine sands, undulating (3 to 5 percent slopes) (McB).—This undifferentiated unit consists of undulating soils on sandy lake plains. Included in mapping were areas of Hamar and Ulen soils. Maddock fine sand and Hecla fine sand occur on convex slopes, and Hamar and Ulen soils occur as small, shallow depressions. These soils have been reworked by wind, and there are many small blowouts and low dunes. In some places the surface layer has been blown away and redeposited to a depth of as much as 12 inches in nearby areas.

The Maddock and Hecla soils have profiles like those described as typical of their respective series, except for the texture of their surface layer. These soils are highly erodible and are too sandy for cultivation. All areas are used for native pasture and hay. Management practices are needed to maintain good stands of native grasses. Proper stocking and well-regulated grazing are beneficial practices. (Capability unit VIe–Sa; Sands range site; Maddock part is in windbreak site 4; Hecla part is in windbreak site 1)

Maddock and Hecla loamy fine sands, undulating (3 to 8 percent slopes) (MhB).—This undifferentiated unit occurs as sloping and undulating areas on sandy uplands and terraces. Maddock loamy fine sand makes up about 80 percent of the unit, and Hecla loamy fine sand, about 20 percent. Included in mapping were small areas of Maddock fine sandy loam and Hecla fine sandy loam. The Maddock soil is on the upper convex slopes, and the Hecla soil is on the lower slopes.

The Maddock soil has a profile like that described as typical of the series. The Hecla soil has a profile like that described as typical of the Hecla series, except that the surface layer is sandier. These soils absorb water readily, but they have low moisture-holding capacity. They are highly susceptible to wind erosion.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Management practices are needed to control wind erosion, conserve moisture, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IVe–2; Sandy range site; Maddock part is in windbreak site 4; Hecla part is in windbreak site 1)

Maddock and Hecla soils, severely eroded (3 to 5 percent slopes) (Mk3).—This undifferentiated unit occurs as hummocky areas on sandy lake plains and on sandy uplands. The soils have been so severely eroded that most of the original surface layer has been removed and redeposited in nearby areas. There are many small dunes, hummocks, and blowouts. They are mostly Maddock fine sand and Hecla fine sand. Included in mapping were small areas of Hamar, Ulen, and Arveson soils in the low areas.

All the acreage is used for pasture or is left idle. The soils are highly erodible and too sandy for cultivation. Management practices are needed to restore a protective vegetative cover of native grasses. Blowouts should be reseeded to adapted species of native grasses. Controlled grazing helps to maintain the stands. (Capability unit VIe–Sa; Sands range site; Maddock part is in windbreak site 4; Hecla part is in windbreak site 1)

Maddock-Hecla loamy fine sands, gently undulating (0 to 3 percent slopes) (MmB).—This complex occurs as gently undulating areas on sandy lake plains. Maddock loamy fine sand makes up about 60 percent of the complex, and Hecla loamy fine sand, about 40 percent. Included in mapping were areas, less than 2 acres in size, of Hamar loamy fine sand, Ulen loamy fine sand, Maddock fine sandy loam, and Hecla fine sandy loam.

The Maddock soil has the profile described as typical of the series. The Hecla soil has a sandier surface layer, but its profile is otherwise like that described as typical of the Hecla series. These soils have been reworked to some extent by wind, and there are many small blowouts where the surface layer has been completely removed and redeposited to a depth of as much as 12 inches in nearby areas. The drifted soil is lighter colored than the original surface layer because it contains less organic matter. These soils absorb water readily, but they have low moisture-holding capacity. They are highly susceptible to wind erosion.

Most of the acreage is used for hay and pasture, but some is cultivated. Management practices are needed to control wind erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, frequent inclusion of grass in the cropping system, and fertilizing. Trees for farmstead and field windbreaks are well suited. (Capability unit IVe–2; Sandy range site; Maddock part is in windbreak site 4; Hecla part is in windbreak site 1)

Nutley Series

The Nutley series consists of deep, moderately well drained soils on lake plains (fig. 7). These soils formed in fine-textured lacustrine sediments.

In a typical profile the surface layer, about 12 inches thick, consists of very dark gray, noncalcareous silty clay. The subsoil, about 8 inches thick, consists of dark grayish-brown, slightly calcareous silty clay that has moderate, medium, prismatic and angular blocky structure. The underlying material consists of light brownish-gray to light olive-gray silty clay that is strongly to moderately calcareous. The material below a depth of about 42 inches is mottled.

Permeability is slow in the subsoil and substratum, and the moisture-holding capacity is high. These soils are well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are suitable crops.

Typical profile of Nutley silty clay in a cultivated area, about 210 feet west and 2,540 feet north of the SE. corner of sec. 5, T. 136 N., R. 66 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate, coarse, prismatic structure and moderate, fine, angular blocky; slightly hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; abrupt, smooth boundary.

A1—6 to 12 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate, coarse, prismatic structure and medium, angular blocky; slightly hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; clear, irregular boundary.

B2—12 to 20 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic structure and angular blocky; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; clear, irregular boundary.

C1ca—20 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; gradual boundary.

C2—36 to 42 inches, light olive-gray (5Y 6/2) silty clay, olive (5Y 4/3) when moist; strong, medium, platy and angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; moderately calcareous; gradual boundary.

C3g—42 to 60 inches, light olive-gray (5Y 6/2) silty clay, olive (5Y 4/3) when moist; common, coarse, prominent, dark-brown (7.5YR 4/4, moist) mottles; strong, medium, platy and angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; moderately calcareous.

The surface layer ranges from 6 to 18 inches in thickness. Tongues of the surface layer extend to a depth of 30 inches in some places. The subsoil ranges from 6 to 12 inches in thickness; it is slightly calcareous to noncalcareous. The underlying material has a zone of strongly calcareous lime just below the subsoil. The lower part is mottled.

Nutley silty clay, level (0 to 3 percent slopes) (NuA).—This soil occurs on glacial lake plains. Included in mapping were areas, less than 2 acres in size, of Fargo silty clay.

This soil has the profile described as typical of the series.

Most of the acreage is cultivated. All the crops commonly grown are well suited. This soil is moderately susceptible to wind erosion if it is fall plowed because the surface layer readily slakes down to sand-sized particles. Management practices are needed to control wind erosion, to conserve moisture, and to maintain tilth, organic-matter content, and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees

Figure 7.—**An area of Nutley soils. This area is on a glacial lake plain near Kulm, in the western part of La Moure County.**

for field and farmstead windbreaks are well suited. (Capability unit IIe-4; Clayey range site; windbreak site 3)

Nutley silty clay, gently sloping (3 to 6 percent slopes) (NuB).—This soil occurs on lake plains. Included in mapping were small areas of Great Bend-Barnes complex, undulating.

This soil has a profile like that described as typical of the series, except that the surface layer is slightly thinner and the lime zone in the substratum is near the surface. Runoff is medium, and the soil is moderately susceptible to water erosion.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. If the soil is fall plowed, the surface layer readily slakes down to sand-sized particles and wind erosion is a hazard. Management practices are needed to control erosion, to conserve moisture, and to maintain tilth, organic-matter content, and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, contour tillage, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-4; Clayey range site; windbreak site 3)

Nutley and Fargo silty clays (0 to 3 percent slopes) (Ny).—This undifferentiated unit occurs on nearly level lake plains. Nutley silty clay makes up about 70 percent of the acreage, and Fargo silty clay, about 30 percent.

These soils have profiles like those described as typical of their respective series. They are deep, fine-textured, and slowly permeable. They are well supplied with organic matter and plant nutrients. The moisture-holding capacity is high.

Most of the acreage is cultivated. The soils are well suited to all the crops commonly grown. They are moderately susceptible to wind erosion if they are fall plowed because the surface layer slakes down readily to sand-sized particles. Management practices are needed to control erosion, provide adequate surface drainage, and maintain tilth and fertility. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing are beneficial practices. Trees are well suited. (Capability unit IIe-4; Clayey range site; Nutley part is in windbreak site 3; Fargo part is in windbreak site 1)

Overly Series

The Overly series consists of deep, moderately well drained soils on glacial lake plains and on terraces and lower foot slopes in the James River Valley. These soils formed in medium-textured to moderately fine textured deposits left by glacial melt water.

In a typical profile the surface layer, about 10 inches thick, consists of very dark gray, noncalcareous silt loam. The subsoil is about 22 inches thick. The upper part consists of dark-gray, noncalcareous silty clay loam that has weak, coarse, prismatic and moderate, fine, subangular blocky structure. The lower part consists of dark grayish-brown, slightly calcareous silty clay that has moderate, fine, subangular blocky structure. The underlying material consists of light brownish-gray, strongly calcareous to slightly calcareous silty clay loam.

The organic-matter content and the supply of plant nutrients are high. The moisture-holding capacity is high, and permeability is moderately slow in the subsoil and substratum.

Most of the acreage is cultivated. Small grain, corn, flax, alfalfa, and other crops are well suited.

Profile of Overly silt loam, about 1,180 feet north and 180 feet east of the SW. corner of sec. 13, T. 133 N., R. 66 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, subangular blocky structure and moderate, fine, crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

A1—6 to 10 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure and moderate, fine, crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; gradual, wavy boundary.

B21—10 to 25 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; weak, coarse, prismatic structure and moderate, fine, subangular blocky; hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

B22—25 to 32 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous; clear, wavy boundary.

C1ca—32 to 40 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; gradual, wavy boundary.

C2—40 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; many, medium, distinct, gray (5Y 5/1, moist) mottles and common, medium, prominent, dark yellowish-brown (10YR 4/4, moist) mottles; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

The surface layer ranges from silt loam to silty clay loam in texture and from 8 to 20 inches in thickness. It is somewhat thicker on foot slopes. The subsoil ranges from 10 to 22 inches in thickness. In many places the lower part is slightly calcareous. Sand occurs below a depth of 4 feet in some places on lake plains. In other areas the texture below a depth of 3 feet ranges from sandy loam to silty clay. A zone of lime accumulation occurs just below the subsoil in most places. Mottles are common in the lower part of the substratum.

Overly soils have a thicker surface layer than Great Bend soils. They are better drained and have fewer mottles in the subsoil and substratum than Perella soils. They lack the lime accumulation just below the surface layer that Bearden soils have. They are finer textured than Gardena soils, but coarser textured than Nutley and Fargo soils.

Overly silt loam (0 to 3 percent slopes) (Oe).—This soil occurs on lake plains and on terraces and lower foot slopes in the James River Valley. Included in mapping were small areas of Gardena loam, Bearden silt loam, and Aberdeen silt loam.

This soil has the profile described as typical of the series. The surface layer is silt loam in most places, but in some areas it is silty clay loam. The moisture-holding capacity is high. Permeability is moderately slow in the subsoil and substratum.

Most of the acreage is cultivated. Small grain, corn, flax, alfalfa, and other crops are well suited. Erosion is not a problem. Management practices are needed to conserve moisture and to maintain tilth, organic-matter con-

tent, and fertility. Among these practices are stubble-mulch tillage, management of crop residue, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc–6; Silty range site; windbreak site 1)

Overly-Aberdeen complex (0 to 3 percent slopes) (Or).—This complex occurs on terraces and lake plains. Overly silt loam makes up about 65 percent of the complex, and Aberdeen silt loam, about 35 percent. Included in mapping were small areas of Exline silt loam and Bearden silt loam.

The Overly soil has the profile described as typical of the series. In most places the surface layer is silt loam, but in some areas it is silty clay loam. The Aberdeen soil has a slowly permeable claypan subsoil that restricts roots and infiltration of moisture.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are suitable crops. The Aberdeen soil is somewhat droughty because of the claypan subsoil. Management practices are needed to improve tilth and permeability, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, frequent inclusion of deep-rooted legumes in the cropping system, application of manure, and fertilizing. Trees are poorly suited, but some are planted for farmstead windbreaks. (Capability unit IIIs–6P; Silty range site; windbreak site 8)

Parnell Series

The Parnell series consists of poorly drained and very poorly drained soils in closed depressions on glacial till plains (fig. 8). These soils formed in medium-textured to moderately fine textured alluvium overlying glacial till.

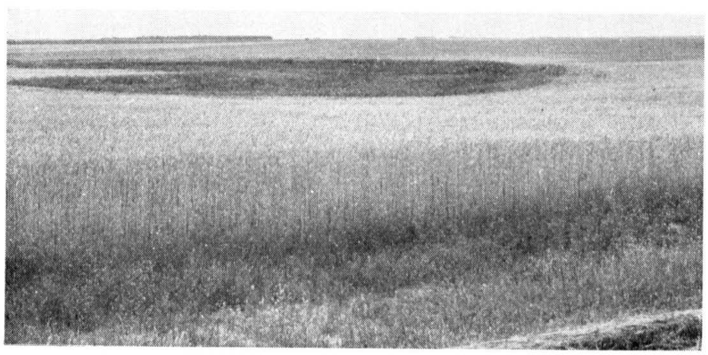

Figure 8.—**An area of Parnell silty clay loam. This soil occupies depressions on glacial till plains.**

In a typical profile the surface layer, about 12 inches thick, consists of very dark gray, noncalcareous silty clay loam. The subsoil, about 6 inches thick, consists of dark-gray, noncalcareous silty clay loam that has moderate, coarse, blocky structure. The underlying material consists of gray to light olive-gray, noncalcareous clay loam. This material is mottled below a depth of about 12 inches.

Permeability is slow, and the soils are frequently ponded because they receive runoff from higher lying soils. The organic-matter content and the supply of plant nutrients are good.

Most of the acreage is used for hay and pasture. Drained areas are suitable for crops, but outlets are lacking in many places. These soils produce large amounts of native grasses, mainly rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass.

Profile of Parnell silty clay loam, 300 feet west and 825 feet north of the SE. corner of sec. 12, T. 135 N., R. 66 W.

A1—0 to 12 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, fine and medium, angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

B2—12 to 18 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; few, fine, faint mottles of olive brown (2.5Y 4/4, moist); moderate, coarse, blocky structure breaking to strong, fine, angular blocky; very hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

C1g—18 to 54 inches, gray (5Y 5/1) clay loam, very dark gray (5Y 3/1) when moist; common, fine, faint mottles of olive brown (2.5Y 4/4, moist); moderate, medium, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

C2g—54 to 60 inches, light olive-gray (5Y 6/2) clay loam, olive gray (5Y 5/2) when moist; many, fine, distinct mottles of brownish yellow (10YR 6/8, moist) and dark yellowish brown (10YR 4/4, moist); massive; very hard when dry, firm when moist, sticky and plastic when wet; noncalcareous.

The surface layer ranges from 8 to 20 inches in thickness, and the subsoil, from 6 to 20 inches. In some places the surface layer is slightly to moderately calcareous, and there is a zone of lime accumulation in the upper part of the substratum.

Parnell soils lack the platy subsurface layer of Tonka soils. They lack the zone of lime accumulation that Vallers soils have. They differ from Perella soils in having formed in local alluvium over glacial till, rather than in deposits left by glacial melt water.

Parnell silty clay loam (0 to 2 percent slopes) (Pa).—This soil is very poorly drained. It occurs as depressions on glacial till plains. These depressions are frequently ponded by runoff water received from surrounding soils. Included in mapping were small areas of Tonka silt loam and Vallers silty clay loam.

Undrained areas are generally too wet for cultivation. In dry years they are occasionally used for late crops of flax, small grain, or millet, but in some years the crop is lost because wetness prevents harvesting. Drained areas produce good crops of small grain, corn, flax, and alfalfa.

The main consideration in management of this soil is to provide adequate surface drainage. Ditches can be used to remove excess water where outlets are available. If drainage is not practical, this soil is better suited to hay and pasture than to other crops. It produces large amounts of native forage. It also provides a good habitat for waterfowl and other wildlife. Drained areas are well suited to trees. (Drained areas are in capability unit IIw–6; undrained areas are in capability unit Vw–WL; both are in Wetlands range site and windbreak site 7)

Peat and Muck, Shallow

Peat and muck, shallow (Pm) consists of deposits of peat and muck that are about 28 inches thick. The deposits are underlain by mineral soil material that has a texture of coarse sand and gravel. Peat consists of partly decomposed grasses, sedges, and rushes. Muck consists of

peat that is sufficiently decomposed that the plant parts from which it formed are not identifiable.

Peat and muck, shallow, is strongly calcareous. It occurs as level seepage areas on lake plains. The water table is at or near the surface throughout most of the growing season.

This land type is too wet for cultivation. All the acreage is used for native vegetation, mainly coarse slough grasses and sedges. The areas produce a large amount of forage; they also provide good wildlife habitat. (Capability unit Vw–WL; Wetlands range site; windbreak site 8)

Perella Series

The Perella series consists of deep, poorly drained to very poorly drained soils. These soils occur as nearly level areas and depressions on lake plains. They formed in medium-textured to moderately fine textured deposits left by glacial melt water.

In a typical profile the surface layer, about 7 inches thick, consists of very dark gray loam. The subsoil, about 16 inches thick, has weak, coarse, prismatic structure. The upper part consists of mottled, dark-gray loam; the lower part consists of light olive-gray and pale-olive silt loam. The underlying material consists of white silt loam that grades to light-gray and light olive-gray silty clay loam. It is strongly to slightly calcareous. The material below a depth of about 30 inches is mottled.

Permeability is moderate in the surface layer and subsoil and slow in the substrata, and the moisture-holding capacity is high. The water table is near the surface after heavy rainfall or rapid snowmelt. These soils have a good supply of organic matter and plant nutrients.

The better drained areas of Perella soils are cultivated, and the wetter areas are used for hay and pasture. Undrained areas are used for native vegetation, such as rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass.

Typical profile of Perella loam in a cultivated field, about 1,600 feet south and 1,300 feet east of the NW. corner of sec. 27, T. 131 N., R. 59 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, coarse and medium, blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; clear, smooth boundary; sodium adsorption ratio 0.3.

B1g—7 to 17 inches, mottled, dark-gray (10YR 4/1) loam, very dark brown (10YR 2/2) or black (10YR 2/1) when moist; organic stains on prism faces and common, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, coarse, prismatic structure breaking to weak, coarse and medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few roots; gradual, irregular boundary; sodium adsorption ratio 2.0.

B2g—17 to 23 inches, mottled, light olive-gray and pale-olive (5Y 6/2 and 6/3) silt loam, olive (5Y 4/3) when moist; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure breaking to weak, coarse and medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few roots; clear, wavy boundary; sodium adsorption ratio 0.7.

C1ca—23 to 30 inches, white (5Y 8/1) silt loam, olive gray (5Y 5/2) when moist; weak, coarse, prismatic structure breaking to weak, coarse and medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very few roots; strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 1.0.

C2ca—30 to 36 inches, mottled, white (5Y 8/1) silt loam, olive gray (5Y 5/2) when moist; common, medium, distinct, brownish-yellow (10YR 6/8) and dark grayish-brown (10YR 4/2) mottles; weak, coarse, prismatic structure breaking to weak, coarse and medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 1.3.

C3g—36 to 46 inches, mottled, light-gray and white (5Y 7/1 and 8/1) heavy silt loam, olive gray and light olive gray (5Y 5/2 and 6/2) when moist; common, fine and medium, distinct, strong-brown (7.5YR 5/8) mottles; massive; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 1.7.

C4g—46 to 60 inches, mottled, light-gray and light olive-gray (5Y 7/1 and 6/2) silty clay loam, olive gray and light olive brown (5Y 5/2 and 2.5Y 5/4) when moist; common, medium, distinct, brown to dark-brown (7.5YR 4/4) and dark reddish-brown (5YR 3/4) mottles and common, coarse, distinct, lime segregations; massive; hard when dry, firm when moist, sticky and plastic when wet; slightly to strongly calcareous; sodium adsorption ratio 1.4.

The surface layer ranges from 7 to 20 inches in thickness, and the subsoil, from 10 to 20 inches in thickness. Patches of clay films occur on ped surfaces in some profiles. In some places sand begins at a depth below 4 feet.

Perella soils are more poorly drained and have more mottles than Gardena and Overly soils. They lack the lime accumulation just below the surface layer that is typical of Borup, Glyndon, Bearden, and Colvin soils. They are finer textured than Tiffany soils. They differ from Parnell soils in having developed in deposits left by glacial melt water, rather than in glacial till.

Perella loam (0 to 2 percent slopes) (Pr).—This soil occurs in shallow to moderately deep depressions on lake plains. Included in mapping were areas, less than 2 acres in size, of Bearden silt loam, Glyndon silt loam, Tiffany loam, Borup silt loam, and Colvin silty clay loam.

This soil is occasionally ponded, and the water table is near the surface after heavy rainfall or rapid snowmelt.

The better drained areas are cultivated, but most areas are too wet for cultivation unless they are adequately drained. In dry years the undrained areas are occasionally used for late crops of small grain, flax, corn, and millet, but excessive wetness may interfere with harvesting. Drained areas produce good crops of small grain, corn, flax, and alfalfa.

The main consideration in management of this soil is to provide adequate surface drainage. Ditches can be used to remove excess water where outlets are available. If drainage is not practical, this soil is better suited to native hay and pasture than to other crops. Undrained areas produce large amounts of native forage, and they also provide a good habitat for waterfowl and other wildlife. Drained areas are well suited to trees. (Drained areas are in capability unit IIw–6; undrained areas are in capability unit Vw–WL; both are in Wetlands range site and windbreak site 7)

Rauville Series

The Rauville series consists of very poorly drained soils that formed in medium-textured to fine-textured alluvium. These soils occur mainly in stream channels in the central and eastern parts of La Moure County, on

bottom lands along the James River, and in seepage areas below upper side slopes in the James River Valley.

In a typical profile the surface layer, about 8 inches thick, consists of gray, moderately calcareous silt loam. The subsurface layer, about 40 inches thick, consists of mottled, gray, moderately calcareous silty clay loam that has weak, coarse, prismatic structure. Below this is mottled, very dark gray, noncalcareous silty clay. The underlying material is mottled, greenish-gray silty clay loam. It contains a few lime concretions and is weakly calcareous.

Rauville soils contain a large amount of organic matter. The water table is near the surface throughout most of the growing season.

These soils are too wet for cultivation, and all areas are used for native hay and pasture. They produce large amounts of native vegetation, mainly coarse slough grasses, reeds, and sedges.

Profile of a Rauville silt loam, 70 feet south and 610 feet east of the NW. corner of sec. 7, T. 136 N., R. 60 W.

A1—0 to 8 inches, gray (N 5/0) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; gradual, wavy boundary.

A12g—8 to 48 inches, gray (N 6/0) silty clay loam, very dark gray (N 3/0) when moist; few, fine, distinct mottles of light olive brown (2.5Y 5/6, moist); weak, coarse, prismatic structure breaking to moderate, coarse, angular blocky; hard when dry, firm when moist, sticky and plastic when wet; moderately calcareous; clear, smooth boundary.

Abg—48 to 54 inches, very dark gray (5Y 3/1) silty clay, black (5Y 2/2) when moist; few, fine, distinct, strong-brown (7.5YR 5/8, moist) mottles; massive; hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; abrupt, wavy boundary.

Cg—54 to 60 inches, greenish-gray (5GY 5/1) silty clay loam, dark greenish gray (5GY 4/1) when moist; few, fine, distinct mottles of dark brown (7.5YR 4/4, moist) and yellowish brown (10YR 5/4, moist); massive; slightly hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; few faint lime concretions.

The surface layer ranges from 6 to 20 inches in thickness and from silt loam to silty clay in texture. It is slightly to strongly calcareous. The A12g horizon ranges from dark gray to very dark gray in color and from silt loam to silty clay loam in texture. The underlying material ranges from silt loam to silty clay loam in texture. It is noncalcareous to strongly calcareous. Below a depth of 36 inches, the texture ranges from coarse sand and gravel to silty clay. Buried profiles are common. Gypsum crystals occur in the substratum in some places.

Rauville soils are more poorly drained than Lamoure soils. They lack the zone of accumulated lime that occurs in the Colvin soils.

Rauville soils (0 to 2 percent slopes) (Ra).—These soils occur mainly in old outwash channels in the central and eastern parts of La Moure County and in oxbows and channels in the James River Valley. The water table is near the surface throughout most of the growing season.

All the acreage is used for hay and pasture. These soils are too wet for cultivation, and drainage is not practical. They produce large amounts of coarse slough grasses, reeds, and such sedges as rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass. The main consideration in management is to restrict grazing when the soils are too wet; otherwise, puddles form and the plant cover is damaged. (Capability unit Vw-WL; Wetlands range site; windbreak site 8)

Rauville soils, sloping 6 to 12 percent slopes) (RaC).—These soils occur in seepage areas below upper side slopes in the James River Valley.

These soils have the profile described as typical of the series. The surface layer is silt loam. The water table is near the surface throughout most of the growing season.

These soils are too wet for cultivation, and drainage is not practical. All the acreage is used for hay and pasture. It produces large amounts of forage, mainly rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass. The main consideration in management is to restrict grazing when the soils are too wet; otherwise, puddles form and the plant cover is damaged. (Capability unit Vw-WL; Wetlands range site; windbreak site 8)

Renshaw Series

The Renshaw series consists of well-drained soils on stream terraces and outwash plains, mainly in the central part of La Moure County, on terraces in the James River Valley, and on outwash plains. These soils are nearly level to gently sloping. They formed over sand and gravel in medium-textured deposits left by glacial melt water.

In a typical profile the surface layer, about 6 inches thick, consists of very dark gray, noncalcareous loam. The subsoil, about 12 inches thick, consists of dark grayish-brown, noncalcareous, friable loam. It has weak, coarse, prismatic and moderate, medium, angular blocky structure. The next layer consists of loose, noncalcareous, grayish-brown loamy coarse sand. The underlying material is loose, noncalcareous, varicolored coarse sand and gravel.

These soils absorb water readily, but they have low to moderate moisture-holding capacity, depending on the depth to sand and gravel. They are moderately well supplied with organic matter and plant nutrients.

Most of the acreage is cultivated, but some is used for hay and pasture. Small grain, corn, flax, and alfalfa are the main crops.

Typical profile of Renshaw loam, in a cultivated area about 170 feet west and 2,680 feet north of the SE. corner of sec. 16, T. 134 N., R. 64 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, medium, crumb and granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

B2—6 to 18 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure and moderate, medium, angular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

IIC1—18 to 22 inches, grayish-brown (10YR 5/2) loamy coarse sand, very dark grayish brown (10YR 3/2) when moist; single grain; loose; noncalcareous; gradual boundary.

IIC2—22 to 60 inches, varicolored coarse sand and gravel; single grain; loose; noncalcareous.

The thickness of the soil material overlying the sand and gravel substratum ranges from 10 to 26 inches. The surface layer ranges from 4 to 12 inches in thickness. The subsoil ranges from very dark grayish brown to very dark brown and dark grayish brown in color and from 4 to 14 inches in thickness. The substratum ranges from medium sand to gravel

in texture, and it is noncalcareous to strongly calcareous. There is a zone of lime accumulation in the upper part of the substratum in some profiles.

Renshaw soils are deeper to sand and gravel than Sioux soils. They have a thinner surface layer and are better drained than Spottswood soils. They are shallower to sand and gravel than Fordville soils, and they lack an accumulation of lime just below the surface layer, which Divide soils have. They are finer textured than Arvilla soils.

Renshaw loam, level (0 to 3 percent slopes) (ReA).—This soil occurs on stream terraces and outwash plains, mainly in the central part of La Moure County and in the James River Valley. Included in mapping were small areas of a Sioux loam and a Fordville loam.

This soil has the profile described as typical of the series.

Nearly all the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. Control of wind erosion is the main problem. Management practices are needed to control erosion, conserve moisture, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIs–5; Silty range site; windbreak site 5)

Renshaw loam, gently sloping (3 to 9 percent slopes) (ReB).—This soil occurs on stream terraces and outwash plains, mainly in the central part of La Moure County, and in the James River Valley. In most places the slope is 3 to 6 percent, though the range is 3 to 9 percent. Included in mapping were small areas of a Sioux loam and a Fordville loam.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are the main crops. This soil is less well suited to cultivated crops than Renshaw loam, level, because water runs off faster and the moisture-holding capacity is lower. Control of wind and water erosion is the main problem, and management practices are needed to control erosion, conserve moisture, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIes–5; Silty range site; windbreak site 5)

Renshaw and Sioux soils, level (0 to 3 percent slopes) (RsA).—This undifferentiated unit consists of soils that are shallow to coarse sand and gravel. These soils occur on outwash plains and terraces. Renshaw loam makes up about 70 percent of the acreage, and Sioux loam and gravelly loam, about 30 percent.

The Renshaw soil is about 10 to 16 inches deep over coarse sand and gravel. The Sioux soil is excessively drained. It has a surface layer of loam or gravelly loam that is underlain by coarse sand and gravel at a depth of less than 12 inches. In some small areas stones are common on the surface.

Most of the acreage is used for hay and pasture, but some areas are cultivated. The main consideration in management is to maintain a good stand of native grass. The most common native grasses are needle-and-thread, blue grama, prairie sandreed, needleleaf sedge, and plains muhly. Trees are poorly suited, but some are planted for farmstead windbreaks. (Capability unit VIs–SwG; Shallow to Gravel range site; windbreak site 8)

Renshaw and Sioux soils, gently sloping (3 to 9 percent slopes) (RsB).—This undifferentiated unit consists of soils that are shallow to coarse sand and gravel. It occurs as gently sloping areas on stream terraces and outwash plains. Renshaw loam makes up about 60 percent of the acreage, and Sioux loam and gravelly loam, about 40 percent.

These soils have a profile like that described as typical of their respective series. The depth to coarse sand and gravel is about 10 to 16 inches in the Renshaw soil but is less than 10 inches in the Sioux soil. In some small areas stones are common on the surface.

Most of the acreage is used for hay and pasture, but some small areas are cultivated. The native vegetation consists mainly of needle-and-thread, blue grama, prairie sandreed, needleleaf sedge, and plains muhly. The main consideration in management is to maintain a good stand of native vegetation. Trees are poorly suited, but some are planted for farmstead windbreaks. (Capability unit VIs–SwG; Shallow to Gravel range site; windbreak site 8)

Ryan Series

The Ryan series consists of poorly drained soils that have a claypan and are subject to flooding. These soils occur as nearly level areas and slight depressions on bottom lands in the James River Valley. They formed in fine-textured alluvium.

In a typical profile the surface layer, about 2 inches thick, consists of black silty clay loam. The subsoil, about 6 inches thick, consists of black silty clay. The upper part has strong to moderate, medium and coarse, columnar structure. The lower part has moderate, medium and coarse, prismatic structure. It is slightly calcareous. The underlying material is black to very dark gray silty clay that is strongly calcareous and contains lime segregations and gypsum crystals.

Permeability is very slow, and the moisture-holding capacity is low. Surface runoff is very slow, and flooding and ponding occur after heavy rainfall or rapid snowmelt. The water table is high in spring, and in many years tillage must be delayed because of wetness. The density of the subsoil and the salts in the substratum restrict root penetration.

Most of the acreage is used for hay and pasture, but some is used for small grain, corn, and alfalfa.

Typical profile of Ryan silty clay in a pasture, 0.3 mile west and 0.4 mile south of the NE. corner of sec. 36, T. 132 N., R. 60 W.

A2—0 to 2 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) when dry; weak, thin, platy and blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many roots; abrupt boundary; sodium adsorption ratio 8.0.

B21—2 to 4 inches, black (10YR 2/1) silty clay, dark gray (5Y 4/1) when dry; strong to moderate, medium and coarse, round-topped, columnar structure breaking to strong, angular blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; common roots throughout; clear, smooth boundary; sodium adsorption ratio 12.9.

B22—4 to 8 inches, black (10YR 2/1) silty clay, dark gray (5Y 4/1) when dry; moderate, medium and coarse, prismatic structure breaking to strong, fine, blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; many roots; slightly calcareous; clear, wavy boundary; sodium adsorption ratio 16.8.

C1—8 to 22 inches, black (10YR 2/1) silty clay, dark gray (N 4/0) when dry; very weak, coarse, prismatic structure breaking to moderate, fine, blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; common roots; strongly calcareous; few lime segregations; gradual boundary; sodium adsorption ratio 25.5.

C2—22 to 36 inches, black (10YR 2/1) silty clay, dark gray (N 4/0) when dry; very weak, medium, prismatic structure breaking to moderate, medium, blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; lime segregations; common fine gypsum crystals; gradual boundary; sodium adsorption ratio 24.1.

C3—36 to 60 inches, very dark gray (5Y 3/1) silty clay, gray (N 5/0) when dry; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous; small soft gypsum crystals; sodium adsorption ratio 21.7.

The surface layer ranges from 1 to 3 inches in thickness. In areas of native grass, the subsoil ranges from 4 to 10 inches in thickness. In cultivated areas the upper part of the subsoil has been mixed with the surface layer. The salinity of the subsoil ranges from slight or moderate to strong, and it increases with depth into the substratum.

Ryan soils differ from Exline soils in having formed in fine-textured alluvium, rather than in deposits left by glacial melt water. The round-topped columnar structure of the subsoil differentiates Ryan soils from Ludden soils.

Ryan silty clay (0 to 2 percent slopes) (Ru).—This soil occurs as nearly level areas and slight depressions on bottom lands in the James River Valley. Included in mapping were areas, less than 2 acres in size, of Ludden silty clay, Lamoure silty clay loam, and Rauville soils.

This soil has the profile described as typical of the series. The surface layer is silty clay loam, and the subsoil is dense, very slowly permeable silty clay.

Most of the acreage is used for hay and pasture. It is not suitable for cultivation, because tillage mixes material from the claypan with the surface layer and the soil becomes very hard and cloddy when dry and sticky when wet. Tall wheatgrass, slender wheatgrass, Russian wildrye, and western wheatgrass are salt-tolerant grasses that can be used to reseed areas that have been cultivated. Well-regulated grazing encourages the increase of the more desirable grasses. Trees are poorly suited. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Ryan-Ludden silty clays (0 to 2 percent slopes) (Ry).—This complex occurs as nearly level areas and slight depressions on bottom lands in the James River Valley. Ryan silty clay and Ludden silty clay occur in about equal proportions. Included in mapping were areas, less than 2 acres in size, of Lamoure silty clay loam, Fargo silty clay, and Rauville soils.

These soils have the profiles described as typical of their respective series. The Ludden soil is deep and fine textured. The Ryan soil is shallow to a dense, slowly permeable claypan. It has a high content of salt.

Most of the acreage is used for hay and pasture. This complex is not suitable for cultivation, because tillage mixes the thin surface layer of the Ryan soil with the claypan and slick spots form. These spots are hard and cloddy when dry and sticky when wet.

This complex is better suited to permanent pasture or hay than to other crops. Salt-tolerant plants grow better on the alkali spots. Tall wheatgrass, slender wheatgrass, Russian wildrye, and western wheatgrass are salt-tolerant grasses that can be used to reseed areas that have been cultivated. Well-regulated grazing encourages the increase of the more desirable grasses. Trees are poorly suited. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Saline Land

Saline land (0 to 2 percent slopes) (Sa) consists of soils that contain such a high concentration of soluble salts that only the most persistent of salt-tolerant plants can grow. Most areas occur on bottom lands and in outwash channels, but some are in depressions where seepage from artesian wells has increased the salinity of the soil. The vegetation consists mainly of inland saltgrass, Nuttall alkaligrass, western wheatgrass, and wild barley. In many places the saltier spots are bare of vegetation.

This land type is too salty for cultivated crops. It is used mainly for pasture. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Sioux Series

The Sioux series consists of excessively drained, nearly level to hilly soils on outwash plains and stream terraces. These soils formed, over coarse sand and gravel, in shallow, medium-textured to moderately coarse textured deposits left by glacial melt water.

In a typical profile the surface layer, about 6 inches thick, consists of dark-gray loam. The underlying material is dark-brown, calcareous coarse sand and gravel; some of the pebbles are crusted with lime.

Permeability is moderately rapid above the coarse sand and gravel substratum, and then it is very rapid. The moisture-holding capacity is very low.

Most of the acreage is used for pasture, but a few areas are cultivated along with surrounding areas of Renshaw and Fordville soils.

Typical profile of Sioux loam, about 1,200 feet north and 850 feet east of the SW. corner of sec. 36, T. 138 N., R. 63 W.

A1—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, fine, blocky and crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abrupt, irregular boundary.

IIC—6 to 60 inches, dark-brown (average color 10YR 3/3, moist) coarse sand and gravel; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; calcareous; pebbles crusted with lime.

The surface layer is black to very dark grayish-brown loam to gravelly loam 4 to 10 inches thick. It is noncalcareous, but the lower part is strongly calcareous in places where there is an accumulation of lime. The underlying material is varicolored coarse sand and gravel that is slightly calcareous to strongly calcareous. The upper part of this material has an accumulation of lime in some places.

Unlike Renshaw, Arvilla, Fordville, Spottswood, and Divide soils, Sioux soils have a substratum of coarse sand and gravel just below the surface layer.

Sioux soils (6 to 30 percent slopes) (So).—These soils occur as sloping to hilly areas on gravelly knobs and ridges, on stream terraces, and on valley side slopes. The depth to coarse sand and gravel is less than 10 inches. In small areas the surface layer contains common to many stones.

These soils are very droughty and are not suitable for cultivation; they are better suited to native pasture. The native grasses consist mainly of needle-and-thread, blue grama, needleleaf sedge, and western wheatgrass. Well-regulated grazing encourages the growth of the more desirable grasses. Trees are poorly suited. (Capability unit VIs–SwG; Shallow to Gravel range site; windbreak site 8)

Spottswood Series

The Spottswood series consists of moderately well drained, nearly level soils on stream terraces and outwash plains. These soils formed, over coarse sand and gravel, in medium-textured deposits left by glacial melt water.

In a typical profile the surface layer, about 15 inches thick, consists of dark-gray, noncalcareous loam. The subsoil, about 15 inches thick, consists of dark grayish-brown loam and grayish-brown, noncalcareous clay loam. The upper part has moderate, coarse, prismatic and medium, blocky structure. The lower part has strong, coarse, prismatic and medium, angular blocky structure. The underlying material consists of grayish-brown, noncalcareous loamy coarse sand that grades to varicolored, slightly calcareous coarse sand and gravel.

Permeability is moderate above the sand and gravel and moderately rapid in the substratum. The moisture-holding capacity is low to moderately high, depending on the depth to sand and gravel. These soils are well supplied with organic matter.

Most of the acreage is cultivated. These soils are fairly well suited to all crops commonly grown in the Area.

Typical profile of Spottswood loam in a cultivated area, about 1,400 feet south and 1,300 feet east of the NW. corner of sec. 7, T. 133 N., R. 60 W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; moderate, medium, subangular blocky and crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

A1—6 to 15 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, coarse, prismatic and blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, irregular boundary.

B21—15 to 25 inches, dark grayish-brown (2.5Y 4/2) loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, prismatic and medium, blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; noncalcareous; abrupt, wavy boundary.

B22—25 to 30 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; strong, coarse, prismatic and medium angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; abrupt, wavy boundary.

IIC1—30 to 33 inches, grayish-brown (2.5Y 5/2) loamy coarse sand, very dark grayish brown (2.5Y 3/2) when moist; weak, medium, blocky structure and single grain; loose; noncalcareous; clear boundary.

IIC2—33 to 60 inches, varicolored coarse sand and gravel; single grain; loose; slightly calcareous.

The thickness of the solum over the coarse sand and gravel substratum ranges from 20 to 36 inches. The surface layer is 10 to 16 inches thick and has granular and blocky structure. The subsoil ranges from 6 to 20 inches in thickness and from loam to clay loam in texture. The substratum is slightly calcareous to strongly calcareous. In places there is a concentration of lime in the upper part of the substratum.

Spottswood soils have a thicker surface layer than Renshaw and Fordville soils. They lack an accumulation of lime just below the surface layer, which Divide soils have. Spottswood soils have a coarse sand and gravel substratum, which is lacking in Gardena soils.

Spottswood loam (0 to 5 percent slopes) (Sp).—This soil occurs on low terraces in the James River Valley. About 90 percent of the acreage is level, but a few small areas slope as much as 5 percent. Included in mapping were areas, less than 2 acres in size, of a Renshaw loam and a Fordville loam.

This soil is moderately susceptible to wind erosion if it is cultivated and not protected. The moisture-holding capacity is low to moderately high.

This soil is well suited to small grain, corn, flax, alfalfa, and other crops commonly grown. Control of wind erosion is the main problem. Management practices are needed to control erosion, conserve moisture, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, and fertilizing. Trees for field and farmstead windbreaks are fairly well suited. (Capability unit IIIs–5; Silty range site; windbreak site 1)

Stirum Series

The Stirum series consists of poorly drained to very poorly drained alkali soils on lake plains. These soils occur as nearly level areas or as slight depressions. They formed in moderately coarse textured and coarse textured deposits left by glacial melt water.

In a typical profile the surface layer, about 6 inches thick, consists of very dark gray, slightly to strongly calcareous fine sandy loam. The subsoil, about 32 inches thick, consists of dark-gray fine sandy loam to light-gray loamy fine sand that is strongly calcareous to very strongly calcareous. Below this is mottled, light olive-gray loamy fine sand. The underlying material consists of mottled light-gray, white, and brownish-gray to gray silt loam and loamy fine sand. This material is very strongly calcareous to strongly calcareous.

Permeability is slow or moderately slow, and the moisture-holding capacity is high. A seasonally high water table is near the surface after heavy rainfall or rapid snowmelt. The density of the subsoil and the high content of salts in the subsoil and substratum limit root penetration. These soils are fairly well supplied with organic matter.

Typical profile of Stirum fine sandy loam in a cultivated field, 300 feet west and 0.3 mile north of the SE. corner of sec. 29, T. 130 N., R. 59 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; weak and moderate, medium, blocky structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; abundant roots; slightly to strongly calcareous; abrupt, smooth boundary; sodium adsorption ratio 19.4.

B21—6 to 10 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; strong, very coarse and coarse, prismatic structure breaking to strong, coarse and medium, blocky; very hard when dry, firm when moist, sticky and slightly plastic when wet; few roots; strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 33.5.

B22—10 to 18 inches, gray (5Y 5/1) fine sandy loam, dark gray (5Y 4/1) when moist; moderate, very coarse, prismatic structure breaking to moderate, coarse and medium, blocky; hard when dry, firm when moist, sticky and slightly plastic when wet; few roots; strongly calcareous; tongues of the B21 horizon extend to a depth of 15 inches; gradual, wavy boundary; sodium adsorption ratio 33.4.

B23—18 to 24 inches, light-gray to gray (5Y 6/1, dry and moist) loamy fine sand; dark-gray (5Y 4/1, moist) and gray (5Y 5/1, dry) organic coatings on ped faces; weak, very coarse, prismatic structure breaking to weak, medium, blocky; hard when dry, friable when moist, slightly sticky and nonplastic when wet; very few roots, strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 42.3.

B24ca—24 to 38 inches, light-gray (5Y 7/1) loamy fine sand, light gray to gray (5Y 6/1) when moist; dark-gray (5Y 4/1, moist) and gray (5Y 5/1, dry) organic coatings on ped faces; weak, very coarse, prismatic structure breaking to weak, medium, blocky; hard when dry, friable when moist, slightly sticky and nonplastic when wet; very strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 37.4.

C1—38 to 44 inches, mottled, light olive-gray (5Y 6/2) loamy fine sand, olive gray (5Y 5/2) when moist; few, fine, distinct, white (5Y 8/1) mottles; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; strongly calcareous; clear, wavy boundary; sodium adsorption ratio 36.9.

IIC2—44 to 50 inches, mottled, light-gray (5Y 7/1) silt loam, grayish brown (2.5Y 5/2) when moist; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; very hard when dry, firm when moist, sticky and slightly plastic when wet; very strongly calcareous; gradual, wavy boundary; sodium adsorption ratio 31.6.

IIC3—50 to 56 inches, mottled, white (N 8/0) silt loam, light olive gray (5Y 6/2) when moist; common, fine, distinct, light brownish-gray (10YR 6/2) and strong-brown (7.5YR 5/6) mottles and few, fine, prominent, dark-brown (7.5YR 3/2) mottles; hard when dry, firm when moist, sticky and slightly plastic when wet; very strongly calcareous; clear, wavy boundary; sodium adsorption ratio 28.1.

IIIC4—56 to 60 inches, mottled, brownish-gray and light-gray to gray (10YR 6/2 and 5Y 6/1) loamy fine sand, dark grayish brown and olive gray (10YR 4/2 and 5Y 5/2) when moist; many, medium, distinct, brown to dark-brown (7.5YR 4/4) mottles and common, medium, prominent, black (5Y 2/1) mottles; soft when dry, loose when moist, slightly sticky and nonplastic when wet; strongly calcareous; sodium adsorption ratio 15.0.

The surface layer ranges from 5 to 12 inches in thickness and from mildly alkaline to moderately alkaline in reaction. The subsoil ranges from very dark gray to light olive gray in color and from 10 to 32 inches in thickness. Its texture ranges from sandy loam to loamy fine sand. The substratum ranges from dark grayish brown to light olive gray in color and from loamy fine sand to fine sand in texture. In many places a layer of very fine sandy loam, silt loam, or silty clay loam occurs at a depth below 40 inches. Crystals of soluble salts and gypsum are common in the lower part of the subsoil and in the substratum.

Stirum soils have an accumulation of lime in the subsoil, which is lacking in Letcher soils. The strong prismatic structure of their subsoil distinguishes them from Arveson and Ulen soils. The parent material of Stirum soils was coarser textured than that of Exline soils.

Stirum fine sandy loam (0 to 2 percent slopes) (Sr).—This soil occurs as nearly level areas and slight depressions on sandy lake plains. The water table is within 3 feet of the surface after heavy rainfall or rapid snowmelt.

This soil has the profile described as typical of the series. In most areas it has a sandy substratum, but in some small areas there is a layer of silt loam or silty clay loam below a depth of 40 inches.

This soil is suitable for cultivation, but control of salinity, excessive wetness, and wind erosion is a problem. Salt-tolerant crops, such as barley, rye, oats, wheat, alfalfa, and tame grasses, are better suited than other crops. Management practices are needed to improve drainage in the subsoil, control erosion, and maintain organic-matter content and fertility. Among these practices are stubble-mulch tillage, management of crop residue, frequent inclusion of deep-rooted legumes and grasses in the cropping system, application of manure, and fertilizing. (Capability unit IIIws-3; Saline Subirrigated range site; windbreak site 8)

Stirum fine sandy loam, very poorly drained (0 to 2 percent slopes) (Ss).—This soil occupies shallow depressions on sandy lake plains. Included in mapping were areas of Arveson fine sandy loam, which make up as much as 30 percent of the acreage in some places. Also included were small areas of Letcher fine sandy loam, Ulen fine sandy loam, Borup silt loam, and a Colvin silt loam.

The water table in this soil is near the surface after heavy rainfall and rapid snowmelt, and it is within 3 feet of the surface throughout most of the growing season.

Undrained areas are too wet for cultivation, and drainage is not practical, because outlets are not available. These areas are generally used for hay and pasture. The vegetation consists mainly of rivergrass, sedges, American mannagrass, northern reedgrass, prairie cordgrass, and a few cattails and rushes. Some undrained areas are used for late crops of small grain, flax, or millet, but harvesting is generally delayed by wetness.

Drained areas are suitable for cultivation, but control of salinity and wind erosion is a problem. (Drained areas are in capability unit IIIws-3; undrained areas are in capability unit Vw-WL; both are in Wetlands range site and windbreak site 8)

Stirum-Exline complex (0 to 2 percent slopes) (St).—This complex occurs as nearly level areas or slight depressions on lake plains. Stirum fine sandy loam makes up about 50 percent of the complex, and Exline silt loam, about 40 percent. The rest consists of Ulen fine sandy loam, Arveson fine sandy loam, and a Colvin silt loam.

These soils have profiles like those described as typical of their respective series. The Exline soil has a thin surface layer and a slowly permeable claypan subsoil that contains a high concentration of soluble salts.

This complex is not suitable for cultivation, because tillage brings the claypan to the surface in areas of Exline soils, and slick spots form. These spots are hard and cloddy when dry and sticky when wet. They are poorly suited to crops because of their slow permeability, high salt content, and poor tilth.

Most of the acreage is used for hay and pasture. The native vegetation consists mainly of Nuttall alkaligrass, inland saltgrass, western wheatgrass, slender wheatgrass, and plains bluegrass. Salt-tolerant grasses, such as tall wheatgrass, Russian wildrye, and bromegrass, can be re-

seeded in areas that have been cultivated. Well-regulated grazing encourages the growth of the more desirable grasses. (Capability unit VIs–SS; Saline Subirrigated range site; windbreak site 8)

Stirum-Letcher fine sandy loams (0 to 2 percent slopes) (Su).—This complex occurs as nearly level areas or slight depressions on lake plains. Stirum fine sandy loam makes up about 50 percent of the complex, and Letcher fine sandy loam about 40 percent. The rest consists of small areas of Ulen fine sandy loam, Hecla fine sandy loam, and Arveson fine sandy loam.

The water table is near the surface after heavy rainfall or rapid snowmelt, and it is within 3 feet of the surface throughout most of the growing season.

These soils are suitable for cultivation, but control of wetness, salinity, and wind erosion is a problem. Salt-tolerant crops, such as barley, rye, oats, wheat, alfalfa, and tame grasses, are well suited. Practices are needed to improve subsurface drainage and to control erosion. Among these practices are frequent inclusion of deep-rooted legumes and grasses in the cropping system, application of manure, stubble-mulch tillage, management of crop residue, and fertilizing. (Capability unit IIIws–3; Saline Subirrigated range site; windbreak site 8)

Svea Series

The Svea series consists of deep, nearly level, moderately well drained soils on glacial till plains in La Moure and Dickey Counties. These soils formed in medium-textured to moderately fine textured glacial till.

In a typical profile the surface layer, about 10 inches thick, consists of black loam. The subsoil, about 11 inches thick, consists of very dark grayish-brown, friable loam that has moderate, medium, prismatic structure breaking to moderate, coarse, subangular blocky. The underlying material consists of mottled, light olive-brown light clay loam and loam. This material is moderately calcareous to calcareous. It has an accumulation of segregated lime just below the subsoil.

Permeability is moderate in the subsoil and moderately slow in the substratum. The moisture-holding capacity is high. These soils are well supplied with organic matter.

Most areas of Svea soils are cultivated along with the closely associated Barnes soils. Small grain, corn, flax, and alfalfa are well suited.

Typical profile of Svea loam, 10 feet east and 500 feet north of the SW. corner of sec. 19, T. 136 N., R. 59 W.

Ap—0 to 7 inches, black (10YR 2/1) loam; weak, coarse, subangular blocky structure breaking to moderate, medium, crumb structure; friable; many roots and pores; abrupt, smooth boundary.

A1—7 to 10 inches, black (10YR 2/1) loam; weak, coarse, prismatic structure breaking to moderate, medium, crumb structure; friable; common fine pores; clear, wavy boundary.

B2—10 to 21 inches, very dark grayish-brown (10YR 3/2) loam; moderate, medium, prismatic structure breaking to moderate, coarse, subangular blocky; thin patches of clay films on vertical ped faces; friable; clear, wavy boundary.

C1ca—21 to 36 inches, light olive-brown (2.5Y 5/4) light clay loam; weak, medium, subangular blocky structure; friable; a few medium-sized nodules of segregated lime; moderately calcareous; gradual, wavy boundary.

C2—36 to 60 inches, light olive-brown (2.5Y 5/4) loam; few, fine, distinct, yellowish-red (5YR 4/6) mottles and a few, fine, faint, gray (5Y 5/1) mottles that become common, coarse, and distinct at a depth of about 42 inches; massive, but breaks under slight pressure to weak, subangular blocky and platy fragments characteristic of the glacial till; friable; calcareous.

The surface layer ranges from 8 to 20 inches in thickness and from loam to silt loam in texture. The subsoil ranges from 6 to 16 inches in thickness and from loam to silt loam in texture. The underlying material is mottled, light olive-brown to olive loam to clay loam glacial till. A zone of lime accumulation occurs just below the subsoil in most profiles; it is strongly to very strongly calcareous.

Svea soils have a thicker surface layer than Barnes soils. They lack the accumulation of lime just below the surface layer, which Hamerly soils have. They formed in glacial till rather than in pebble-free deposits left by glacial melt water, which was the parent material of Gardena soils.

Svea loam (0 to 2 percent slopes) (Sv).—This soil occurs on glacial till plains. Included in mapping were areas, less than 2 acres in size, of Barnes, Hamerly, and Tonka soils.

Most of the acreage is cultivated. Small grain, corn, flax, and alfalfa are suitable crops. Management practices are needed to conserve moisture and maintain fertility. Erosion is not a problem. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial practices. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc–6; Silty range site; windbreak site 1)

Svea-Barnes loams (0 to 3 percent slopes) (Sw).—This complex occurs as nearly level areas on glacial till plains. Svea loam makes up about 60 percent of the complex, and Barnes loam about 40 percent. The Svea soil occupies the lower landscape positions, below the Barnes soil. Included in mapping were small areas of Hamerly, Parnell, and Tonka soils.

These soils have the profiles described as typical of their respective series. They have high moisture-holding capacity, and they are readily permeable to roots, air, and water. Runoff is slow. Erosion is not a problem.

Small grain, corn, flax, alfalfa, and tame grasses are well suited (fig. 9).

Management practices are needed to conserve moisture and maintain fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial practices. Trees for field and farmstead windbreaks are well suited. (Capability unit IIc–6; Silty range site; Svea part is in windbreak site 1; Barnes part is in windbreak site 2)

Tiffany Series

The Tiffany series consists of deep, somewhat poorly drained to poorly drained soils. These soils occur in shallow depressions on uplands. They formed in moderately coarse textured to medium-textured deposits left by glacial melt water.

In a typical profile the surface layer, about 11 inches thick, consists of very dark gray loam. The subsoil, about 11 inches thick, consists of mottled, dark-gray, friable fine sandy loam that has moderate, coarse, prismatic structure breaking to moderate, medium, blocky. The next layer is mottled, light-gray to gray, very friable fine sandy loam. Below this is mottled, loose, yellowish-brown and white fine sand. This is underlain by mottled, white and light-gray loamy fine sand.

Figure 9.—A good crop of small grain on Svea-Barnes loams.

These soils contain a good supply of organic matter. They are moderately permeable, and water moves through the profile readily. They have a seasonally high water table that rises to the surface after heavy rainfall or rapid snowmelt.

Most of the acreage is cultivated, but some areas are used for hay and pasture. Drained areas are suitable for small grain, corn, flax, and alfalfa. Undrained areas are intermittently cultivated, but in many years they are too wet for planting early in spring and are used for small grain, flax, millet, and sudangrass, which can be planted late in the season. In some years they are left idle because of wetness. Areas used for hay or pasture provide large amounts of native forage.

Typical profile of Tiffany loam in a cultivated field, 400 feet west and 0.15 mile south of the NE. corner of sec. 28, T. 131 N., R. 59 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; moderate, fine and medium, blocky and granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; abrupt, smooth boundary.

A1—7 to 11 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; moderate, coarse, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary.

Bg—11 to 22 inches, mottled, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; common, medium, distinct, brown to dark-brown (10YR 4/3) mottles; moderate, coarse, prismatic structure breaking to moderate, medium, blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; plentiful roots; clear, wavy boundary.

C1g—22 to 36 inches, mottled, light-gray to gray (5Y 6/1) fine sandy loam, olive (5Y 4.5/3) when moist; common, medium, prominent, black (10YR 2/1) mottles and many, medium, distinct, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) mottles; moderate, coarse, prismatic structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few roots; clear, wavy boundary.

C2g—36 to 50 inches, mottled, yellowish-brown (10YR 5/4) and white (5Y 8/2) fine sand, dark yellowish brown (10YR 4/4) and light olive gray (5Y 6/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; clear, wavy boundary.

C3g—50 to 60 inches, mottled, white (5Y 8/2) and light-gray (5Y 7/2) loamy fine sand, light olive gray (5Y 6/2), pale olive (5Y 6/3), and olive (5Y 4/3) when moist; common, medium, distinct, dark yellowish-brown (10YR 4/4) mottles; single grain; soft to loose when dry, very friable to loose when moist, slightly sticky and nonplastic when wet.

The surface layer ranges from 6 to 20 inches in thickness and from loam to fine sandy loam in texture. The subsoil ranges from very dark grayish brown to very dark gray or dark gray in color and from loam to fine sandy loam in texture. It is 8 to 20 inches thick. It is slightly acid to neutral in reaction. The texture of the underlying material ranges from fine sand to silty clay loam.

Tiffany soils are finer textured than Hamar and Venlo soils, but they are coarser textured than Perella soils. They are more poorly drained than Gardena and Embden soils, and they have more distinct mottling in the subsoil. They lack a lime concentration, which Glyndon and Ulen soils have.

Tiffany fine sandy loam (0 to 2 percent slopes) (Tf).—This soil occurs in shallow depressions on lake plains. Included in mapping were areas, less than 2 acres in size, of Hecla fine sandy loam, Embden fine sandy loam, and Ulen fine sandy loam.

This soil has a profile similar to the one described as typical of the series, except that it has a surface layer of fine sandy loam. Permeability is moderate. The water table rises nearly to the surface after heavy rainfall or rapid snowmelt.

Drained areas are well suited to small grain, corn, flax, and alfalfa. Although wetness is the major hazard, this soil is also susceptible to wind erosion if it is cultivated and not protected. Undrained areas are intermittently cultivated. In dry years they are worked along with surrounding areas of better drained soils. In wet years, however, planting may be delayed 2 to 3 weeks, or the soil may be left idle the entire season because of wetness.

Management practices are needed to provide adequate drainage, control wind erosion, and maintain fertility. Drainage ditches can be used to remove excess water wherever outlets are available. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial practices. Drained areas are well suited to trees. (Capability unit IIIwe-3; Subirrigated range site; windbreak site 7)

Tiffany fine sandy loam, silty substratum (0 to 2 percent slopes) (Tg).—This soil occurs in shallow depressions on lake plains. It has a profile like that described as typical of the series, except that it has a surface layer of fine sandy loam and a layer of very fine sandy loam, silt loam, or silty clay loam below a depth of 40 inches. Permeability is moderate above the substratum, but it is moderately slow in the substratum. The water table rises nearly to the surface after heavy rainfall or rapid snowmelt.

Drained areas are well suited to small grain, corn, flax, and alfalfa. Although wetness is the major hazard, this soil is also susceptible to wind erosion if it is cultivated and not protected. Undrained areas are intermittently cultivated. In dry years they are cultivated and planted along with surrounding areas of better drained soils. In wet years, however, planting may be delayed 2 to 3 weeks, or the soil may be left idle the entire season because of wetness.

Management practices are needed to improve drainage, control wind erosion, and maintain fertility. Drainage ditches can be used to remove excess water wherever outlets are available. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial practices. Drained areas are well suited to trees. (Capability unit IIIwe-3; Subirrigated range site; windbreak site 7)

Tiffany loam (0 to 2 percent slopes) (Tn).—This soil occurs in shallow depressions on uplands in the southeastern part of La Moure County and on lake plains. Included in mapping were small areas of Gardena loam and Embden loam.

This soil has the profile described as typical of the series. It receives runoff from surrounding areas of higher lying soils, and the water table rises to the surface after heavy rainfall and rapid snowmelt.

Drained areas are well suited to small grain, corn, flax, and alfalfa. Undrained areas are intermittently cultivated. In dry years they are worked along with surrounding areas of better drained soils. In wet years, however, planting may be delayed 2 to 3 weeks, or the soil may be left idle the entire season because of wetness.

Management practices are needed to provide adequate drainage and to maintain fertility. Drainage ditches can be used to remove excess water wherever satisfactory outlets are available. Stubble-mulch tillage, management of crop residue, and fertilizing are beneficial practices. Drained areas are well suited to trees. (Capability unit IIw-6; Subirrigated range site; windbreak site 7)

Tonka Series

The Tonka series consists of somewhat poorly drained to poorly drained soils. These soils occur as shallow depressions on glacial till plains and lake plains. They formed in medium-textured to moderately fine textured local alluvium and deposits left by glacial melt water. The Tonka soils in this Survey Area are the same as the Tetonka soils in adjoining Sargent County.

In a typical profile the surface layer, about 7 inches thick, consists of very dark gray, noncalcareous silt loam. The subsurface layer, about 4 inches thick, consists of grayish-brown, very friable silt loam that has weak, medium, platy structure. The subsoil, about 25 inches thick, consists of grayish-brown, noncalcareous, firm silty clay loam that has moderate, coarse, angular blocky structure breaking to strong, fine, subangular blocky structure. The underlying material consists of mottled, light olive-gray, light-gray, and gray clay loam. It is noncalcareous in the upper part but is very strongly calcareous and strongly calcareous in the lower parts. Lime concretions are common between depths of 56 and 60 inches.

Permeability is moderate in the surface and subsurface layers, but it is moderately slow in the subsoil. It is moderately slow to moderately rapid in the substratum. The moisture-holding capacity is high. These soils receive runoff from higher lying soils and are occasionally ponded after heavy rainfall and rapid snowmelt. They are well supplied with organic matter.

Most of the acreage is used for hay and pasture, but some areas are cultivated. Drained areas are well suited to all the crops commonly grown in the Area. In dry years, undrained areas are cultivated along with surrounding areas of better drained soils, but in wet years these areas are left idle or are used for crops that can be planted late in the season. Millet, flax, and small grain are suitable crops.

Typical profile of Tonka silt loam, about 0.5 mile east and 65 feet south of the NW. corner of sec. 25, T. 135 N., R. 60 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, coarse, subangular blocky structure breaking to moderate, fine, granular; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

A2—7 to 11 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; few, fine, faint, dark-brown (10YR 3/3, moist) mottles; weak, medium, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

B2—11 to 36 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; gradual, wavy boundary.

C1g—36 to 50 inches, light olive-gray (5Y 6/2) clay loam, olive gray (5Y 5/2) when moist; many, medium, distinct mottles of light olive brown (2.5Y 5/4, moist) and few, medium, distinct mottles of yellowish brown (10YR 5/6, moist); hard when dry, firm when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

C2ca—50 to 56 inches, light-gray (5Y 7/1) clay loam, gray (5Y 5/1) when moist; many, fine, distinct mottles of light olive brown (2.5Y 5/6, moist); hard when dry, firm when moist, sticky and plastic when wet; very

strongly calcareous; common lime concretions; gradual, wavy boundary.

C3g—56 to 60 inches, gray (5Y 6/1) clay loam, gray (5Y 5/1) when moist; many, medium, distinct mottles of light olive brown (2.5Y 5/6, moist) and many, strong, prominent mottles of dark brown (7.5YR 4/4, moist); hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous.

The surface layer ranges from 6 to 20 inches in thickness, and the subsurface layer from less than 1 inch to 16 inches. The subsoil ranges from 10 to 26 inches in thickness and from silty clay to silty clay loam in texture. The depth to lime ranges from 3 to 50 inches. The texture of the substratum is typically clay loam or silty clay loam, but in a few areas fine sand or loamy fine sand occurs at a depth below 4 feet.

Tonka soils have a platy subsurface layer, which is lacking in Parnell soils. They lack an accumulation of lime just below the surface layer, which Vallers and Hamerly soils contain. They differ from Cresbard and Cavour soils in having a mottled subsurface layer and in being free of salts to a depth of 5 feet.

Tonka soils (0 to 2 percent slopes) (To).—These soils occur in shallow depressions on glacial till plains and on lake plains. Included in mapping were small areas of Parnell silty clay loam and of Svea loam.

The surface layer is silt loam in most places, but in a few places it is fine sandy loam. These soils receive runoff from higher lying soils, and they are occasionally ponded.

Drained areas are well suited to small grain, corn, flax, and alfalfa. Undrained areas are frequently too wet to be planted early in spring, and they are used for late crops of small grain, flax, sudangrass, and millet. In some years the soils must be left idle throughout the season because of wetness. Drained areas are well suited to trees. (Capability unit IIw–6; Overflow range site; windbreak site 7)

Tonka and Parnell soils (0 to 2 percent slopes) (Tp).—This undifferentiated unit consists of deep, medium-textured to moderately fine textured, poorly drained soils. These soils occur in shallow depressions on glacial till plains. Tonka silt loam makes up about 75 percent of the acreage, and Parnell silty clay loam about 25 percent. Included in mapping were small areas of Vallers silty clay loam and of Hamerly loam.

These soils have profiles like those described as typical of their respective series. They receive runoff from higher lying soils and occasionally become ponded after heavy rains or rapid snowmelt. Surface drainage generally can be improved by constructing drainage ditches where outlets are available.

Drained areas are well suited to small grain, corn, flax, and alfalfa. In many years undrained areas are too wet for planting early in spring, and they are used for late crops of small grain, flax, sudangrass, and millet. In some years the soils must be left idle because of wetness. Erosion is not a problem. Drained areas are well suited to trees. (Capability unit IIw–6; Overflow range site; windbreak site 7)

Ulen Series

The Ulen series consists of somewhat poorly drained, calcareous soils. These soils occur as nearly level areas or as slight depressions on lake plains. They formed in moderately coarse textured and coarse textured deposits left by glacial melt water.

In a typical profile the surface layer, about 12 inches thick, consists of very dark gray, strongly calcareous fine sandy loam. The next layer, about 4 inches thick, is light-gray to gray and white fine sandy loam that has very weak, medium, blocky structure and is strongly to very strongly calcareous. Below this is a buried horizon of gray, mottled fine sandy loam that has weak, medium, blocky structure and is very strongly calcareous. The upper part of the underlying material is light-gray, mottled loamy fine sand that has weak, coarse, prismatic structure breaking to weak, medium, blocky structure and single grain. It is very strongly calcareous. Below this is light-gray to light brownish-gray, slightly calcareous, loose fine sand.

Permeability is moderately rapid, and the moisture-holding capacity is moderate. The water table is near the surface after heavy rainfall or rapid snowmelt.

Most of the acreage is cultivated, but some is used for hay and pasture. These soils are suited to all the crops commonly grown, but they are highly susceptible to wind erosion if cultivated and not protected.

Typical profile of Ulen fine sandy loam in a pasture, 0.2 mile east and 0.2 mile north of the center of sec. 15, T. 130 N., R. 59 W.

A1—0 to 12 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; moderate, medium, blocky and granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant roots; strongly calcareous; clear, wavy boundary; sodium adsorption ratio 0.8.

C1ca—12 to 16 inches, light-gray to gray and white (N 6/0 and N 8/0) fine sandy loam, dark grayish brown and light brownish gray (2.5Y 4/2 and 6/2) when moist; very weak, medium, blocky structure; soft to loose when dry, very friable to loose when moist, nonsticky and nonplastic when wet; few roots; strongly to very strongly calcareous; abrupt, smooth boundary; sodium adsorption ratio 1.2.

Abca—16 to 20 inches, mottled, gray (N 5/0) fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; common, medium, distinct, light-gray (N 7/0) mottles; weak, medium, blocky structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few roots; very strongly calcareous; clear, smooth boundary; sodium adsorption ratio 2.1.

C2ca—20 to 36 inches, mottled, light-gray (5Y 7/1) loamy fine sand, light olive gray (5Y 6/2) when moist; few, medium, prominent, black (10YR 2/1, moist and dry) mottles; weak, coarse, prismatic structure breaking to weak, medium, blocky structure and single grain; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; few roots; very strongly calcareous; clear, smooth boundary; sodium adsorption ratio 4.7.

C3—36 to 42 inches, light-gray (5Y 7/2) fine sand, olive gray (5Y 5/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; slightly calcareous; clear, smooth boundary; sodium adsorption ratio 5.1.

C4—42 to 54 inches, light-gray to light brownish-gray (2.5Y 6.5/2) fine sand, dark grayish brown (2.5Y 4/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; slightly calcareous; clear, smooth boundary; sodium adsorption ratio 2.2.

C5—54 to 60 inches, light brownish-gray (2.5Y 6/2) fine sand, dark grayish brown (2.5Y 4/2) when moist; single grain; loose when dry, loose when moist, nonsticky and nonplastic when wet; sodium adsorption ratio 1.5.

The surface layer ranges from 6 to 14 inches in thickness and from fine sandy loam to loamy fine sand in texture. It is

mildly alkaline to moderately alkaline. The C1ca horizon ranges from 4 to 24 inches in thickness and from fine sandy loam to fine sand in texture. The underlying material ranges from fine sandy loam to fine sand. In some profiles a layer, about 12 inches thick, of silty clay loam, silt loam, or very fine sandy loam occurs below a depth of 40 inches.

Ulen soils have a concentration of lime in the profile that is lacking in Embden, Hamar, Hecla, and Tiffany soils. They are better drained and are not so strongly mottled as Arveson soils. They are coarser textured than Glyndon soils.

Ulen fine sandy loam (0 to 2 percent slopes) (Ue).—This soil occurs as nearly level areas or slight depressions on sandy lake plains. Included in mapping were areas, less than 2 acres in size, of Arveson fine sandy loam, Glyndon silt loam, Hamar fine sandy loam, and Hecla fine sandy loam.

This soil has the profile described as typical of the series. The moisture-holding capacity is moderate, and the soil is highly susceptible to wind erosion.

Most of the acreage is cultivated, but some areas are used for hay and pasture. Small grain, corn, flax, and alfalfa are fairly well suited. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 1)

Ulen fine sandy loam, silty substratum (0 to 2 percent slopes) (Uf).—This soil occurs as nearly level areas or slight depressions on sandy lake plains. Included in mapping were areas, less than 2 acres in size, of Hecla fine sandy loam, Hamar fine sandy loam, Glyndon silt loam, and Arveson fine sandy loam.

This soil has a profile like that described as typical of the series, except that there is a layer of very fine sandy loam, silt loam, or silty clay loam below a depth of about 40 inches. Permeability is rapid above this material, but in the material it is moderately slow. The moisture-holding capacity is high. Wind erosion is a severe hazard.

Most of the acreage is cultivated, but some areas are used for pasture and hay. Small grain, corn, flax, and alfalfa are fairly well suited. Management practices are needed to control erosion, conserve moisture, and maintain fertility. Among these practices are stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, and fertilizing. Trees for field and farmstead windbreaks are well suited. (Capability unit IIIe-3; Sandy range site; windbreak site 1)

Ulen-Hamar complex (0 to 2 percent slopes) (Uh).—This complex occurs as nearly level areas and slight depressions on sandy lake plains. About 50 percent of the acreage consists of Ulen fine sandy loam, and about 40 percent of Hamar loamy fine sand. The rest consists of Hecla fine sandy loam, Glyndon silt loam, Tiffany fine sandy loam, and Arveson fine sandy loam.

These soils have profiles like those described as typical of their respective series, except that in some places the material below a depth of 40 inches is very fine sandy loam, silt loam, or silty clay loam. The water table is near the surface after heavy rainfall or rapid snowmelt. These soils are highly susceptible to wind erosion if they are cultivated and not protected.

Most of the acreage is used for pasture and hay, but some areas are cultivated. Small grain, corn, flax, and alfalfa are the main crops. The main management problems are control of wind erosion, improvement of subsurface drainage, and maintenance of fertility. Stubble-mulch tillage, management of crop residue, stripcropping, establishing windbreaks, drill seeding, inclusion of grass and legumes in the cropping system, and fertilizing are beneficial. (Capability unit IIIe-3; Sandy range site; Ulen part is in windbreak site 1; Hamar part is in windbreak site 7)

Vallers Series

The Vallers series consists of poorly drained, calcareous soils. These soils occur as level, low-lying flats and shallow depressions and in drainageways on till plains. They formed in medium-textured to moderately fine textured glacial till.

In a typical profile the surface layer, about 8 inches thick, consists of very dark gray, slightly calcareous silty clay loam. The next layer, about 14 inches thick, consists of light-gray, very strongly calcareous loam that has weak, coarse, prismatic and subangular blocky structure. This layer contains distinct lime concretions. Below this is mottled, light-gray to light olive-gray clay loam that is slightly calcareous. This material has weak, coarse, prismatic and subangular blocky structure to a depth of about 45 inches. Below this depth, the material is massive.

Permeability is slow. The water table rises to the surface after heavy rainfall or rapid snowmelt. It is within 3 to 5 feet of the surface throughout most of the growing season.

Most of the acreage is used for hay and pasture, but some areas are cultivated along with adjoining better drained soils. Drained areas are well suited to crops. Undrained areas are suitable for cultivation only in the drier years.

Typical profile of Vallers silty clay loam, about 1,980 feet east and 80 feet south of the NW. corner of sec. 29, T. 135 N., R. 60 W.

A1—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to moderate, medium, granular; slightly hard when dry, friable when moist, sticky and plastic when wet; slightly calcareous; gradual, smooth boundary.

C1ca—8 to 22 inches, light-gray (5Y 7/1) loam, gray (5Y 6/1) when moist; weak, coarse, prismatic and subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; few, distinct lime concretions; gradual, smooth boundary.

C2g—22 to 45 inches, light-gray (5Y 6/1) clay loam, gray (5Y 5/1) when moist; common, coarse, prominent mottles of brownish yellow (10YR 6/6, moist); weak, coarse, prismatic structure and subangular blocky; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous; gradual, wavy boundary.

C3csg—45 to 60 inches, light olive-gray (5Y 6/2) clay loam, gray (5Y 5/1) when moist; few, fine, faint mottles of brownish yellow (10YR 6/6, moist); massive; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

The surface layer ranges from 6 to 12 inches in thickness. In some places the lower part contains accumulated lime. The C1ca horizon ranges from 8 to 18 inches in thickness and from loam to clay loam in texture. The underlying material ranges from gray to olive gray in color. It is slightly calcareous to strongly calcareous.

Vallers soils are more poorly drained than Hamerly soils, and they contain more mottles in the substratum than those soils. They have a zone of lime accumulation, which is lacking in Parnell soils. Vallers soils lack the platy subsurface layer that Tonka soils have.

Vallers silty clay loam (0 to 2 percent slopes) (Va).—This soil occurs as level, low-lying flats and shallow depressions and in drainageways on till plains throughout La Moure County. Included in mapping were small areas of Hamerly loam and Parnell silty clay loam.

Drained areas are suitable for small grain, corn, flax, millet, and alfalfa. In dry years undrained areas are cultivated along with surrounding areas of better drained soils. In wet years planting may be delayed 2 to 3 weeks, or even the entire season. Some of the undrained areas are used for hay and pasture, and they produce large amounts of native forage.

Management practices are needed to provide adequate drainage and to maintain tilth and fertility. Drainage ditches can be used wherever outlets are available. Stubble-mulch tillage, management of crop residue, and fertilizing are beneficial. Drained areas are suited to trees. (Capability unit IIw-4L; Subirrigated range site; windbreak site 8)

Venlo Series

The Venlo series consists of very poorly drained soils in depressions on sandy uplands. These soils formed in coarse-textured deposits left by glacial melt water.

In a typical profile the surface layer, about 10 inches thick, consists of very dark gray, noncalcareous fine sandy loam. This is underlain by a transitional layer, about 14 inches thick, of dark-gray, noncalcareous fine sandy loam that has weak, medium, granular structure. The underlying material is mottled, pale-olive, noncalcareous loamy fine sand. This material is single grain.

Permeability is moderately rapid, except in soils that have substrata of glacial till, where it is moderately slow. The water table rises to the surface after heavy rains or rapid snowmelt, and the soils are frequently ponded. The supply of organic matter is good.

Most of the acreage is used for hay and pasture. The soils produce large amounts of rivergrass, American mannagrass, sedge, and prairie cordgrass. Undrained areas are too wet for cultivation.

Typical profile of Venlo fine sandy loam, about 0.5 mile west and 275 feet north of the SE. corner of sec. 30, T. 133 N., R. 62 W.

A1—0 to 10 inches, very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) when moist; moderate, medium, granular structure; soft when dry, very friable when moist; noncalcareous; clear, wavy boundary.

AC—10 to 24 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, medium, granular structure; slightly hard when dry, very friable when moist; noncalcareous; gradual, wavy boundary.

Cg—24 to 60 inches, pale-olive (5Y 6/3) loamy fine sand, olive (5Y 5/3) when moist; many, coarse, prominent mottles of dark yellowish brown (10YR 4/4, moist); single grain; slightly hard when dry, loose when moist; noncalcareous.

The surface layer ranges from 8 to 12 inches in thickness and from fine sandy loam to loam in texture. In some areas clay loam glacial till occurs below a depth of 36 inches.

Venlo soils are more poorly drained than Hamar soils. They are coarser textured than Tiffany soils. They lack the accumulation of lime below the surface layer, which Arveson soils contain.

Venlo fine sandy loam (0 to 2 percent slopes) (Ve).—This soil occurs in depressions on sandy uplands. The water table is at the surface throughout most of the growing season, and the soil is occasionally ponded.

Most of the acreage is used for hay and pasture. This soil produces large amounts of slough grasses, sedges, and rushes. It is suitable for cultivation only if it is drained, but outlets generally are not available. (Capability unit Vw-WL; Wetlands range site; windbreak site 7)

Use and Management of the Soils

This section discusses the use and management of the soils for crops, range, windbreaks, wildlife habitat, and engineering. It explains the system of capability classification used by the Soil Conservation Service, and it gives estimated yields of principal crops.

In addition, this section discusses the characteristics of soils that affect their use and management under irrigation.

Management of the Soils for Crops [3]

The main problems in managing the soils of this Survey Area for crops are conserving moisture, controlling erosion, and maintaining fertility. Other problems are caused by salinity, poor tilth, and excessive wetness.

Most of the soils are suitable for cultivation, but conservation of moisture is essential for good yields. In dryland farming, practices are needed to reduce evaporation, to slow runoff, to increase infiltration of water, and to control weeds.

Controlling wind and water erosion is also important in managing these soils. Susceptibility to erosion varies with the length and steepness of the slope, the texture of the surface layer, and the condition of the vegetative cover. Most of the practices that are useful in controlling erosion also help to conserve moisture. Among these practices are management of crop residue, stubble-mulch tillage, stripcropping, field windbreaks, cover crops, buffer strips, contour tillage, grassed waterways, minimum tillage, and emergency tillage. Generally, a combination of practices is needed.

Among the practices that help to maintain fertility are the frequent inclusion of legumes and grasses in the cropping system, the conservation of crop residue, and the application of commercial fertilizer and barnyard manure. Control of erosion also helps to maintain fertility.

Management of irrigated soils

In table 2 the soils of the Survey Area that are suitable for irrigation are listed, and the main limitations for gravity and sprinkler systems are given. Ratings of the estimated irrigation potential of the soils are also given in the table, as well as some of the important management problems. Only the soils in the irrigation districts are shown in table 2. The irrigation district is outlined on the soil maps.

[3] By EDWARD R. WEIMER, agronomist, Soil Conservation Service.

TABLE 2.—*Irrigation ratings, limitations, and management problems*

[Soils not listed are not suitable for irrigation]

Map symbols	Soil	Estimated irrigation potential and irrigation ratings: Gravity system: Without drainage or leveling	Gravity system: With drainage or leveling	Sprinkler system: Without drainage	Sprinkler system: With drainage	Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
Ab	Aberdeen silt loam.[1]	Unsuitable	Poor to fair.	Poor	Fair	Slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Ae	Aberdeen-Exline complex.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Slow and very slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Af	Arveson fine sandy loam.[2]	Unsuitable to poor.	Fair	Poor	Fair	Moderate moisture-holding capacity; high water table.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
An	Arveson fine sandy loam, very poorly drained.	Unsuitable to poor.	Fair	Unsuitable to poor.	Fair	Moderate moisture-holding capacity; high water table.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
ArA	Arvilla sandy loam, level.	Poor	Fair to poor.	Fair to poor.	Fair to poor.	Low moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
ArB	Arvilla sandy loam, undulating.	Poor	Fair to poor.	Fair to poor.	Fair to poor.	Low moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
BaC	Barnes loam, rolling.	Unsuitable	Unsuitable	Poor to fair.	Poor to fair.	Moderately slow permeability in substratum; salinity. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
BbC	Barnes-Buse loams, rolling.	Unsuitable	Unsuitable	Poor to fair.	Poor to fair.	Moderately slow permeability in substratum; salinity. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Be	Barnes stony loam.	Unsuitable	Unsuitable	Poor to fair.	Poor to fair.	Moderately slow permeability in substratum; salinity; stoniness. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
BnB	Barnes-Svea loams, undulating.	Unsuitable to poor.	Fair to good.	Fair to good.	Good	Moderately slow permeability in substratum; salinity. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Bo	Bearden silt loam.[1]	Poor	Fair to good.	Fair to good.	Good	Moderately slow permeability in subsoil and substratum; salinity; high water table.	Waterlogging; salting.

See footnotes at end of table.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings: Gravity system: Without drainage or leveling	Gravity system: With drainage or leveling	Sprinkler system: Without drainage	Sprinkler system: With drainage	Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
Br	Bearden silt loam, saline.	Unsuitable to poor.	Fair to good.	Poor to fair.	Fair to good.	Slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Bs	Bearden-Exline complex.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Moderately slow to very slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Bt	Borup silt loam	Unsuitable	Good	Poor	Good	Salinity; high water table.	Waterlogging; salting.
Bu	Borup silt loam, very poorly drained.	Unsuitable	Good	Unsuitable to poor.	Good	Salinity; high water table.	Waterlogging; salting.
BvE	Buse-Barnes loams, steep.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Steep, hilly topography; moderately slow permeability in substratum; salinity. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Ce	Claire sandy loam [1].	Poor	Poor	Poor	Poor	Low moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Ch	Colvin silty clay loam.	Unsuitable	Fair to good.	Poor	Good	Moderately slow permeability in subsoil and substratum; salinity; high water table.	Waterlogging; salting.
Co	Colvin soils, saline.	Unsuitable	Fair to good.	Poor	Good	Moderately slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting
Cs	Colvin soils, very poorly drained. [1]	Unsuitable	Fair to good.	Unsuitable to poor.	Good	Moderately slow permeability in subsoil and substratum; salinity; high water table.	Waterlogging; salting.
Cv	Cresbard and Cavour loams.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Slow and very slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Dd	Divide loam [1]	Poor	Fair to good.	Fair to good.	Fair to good.	High moisture-holding capacity; high water table.	Percolation loss.
EaA	Eckman loam, level.	Poor	Good	Good	Good	None	None.
EaB	Eckman loam, gently sloping.	Poor	Good	Good	Good	For gravity system only: topography.	For gravity system only: distributing water; water erosion.
EaC	Eckman loam, sloping.	Unsuitable	Unsuitable	Fair	Fair	For gravity system only: topography.	For gravity system only; distributing water; water erosion.

See footnotes at end of table.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
EcC	Egeland fine sandy loam, sloping.	Unsuitable	Unsuitable	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: topography.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
EgA	Egeland-Embden fine sandy loams, level.	Poor	Fair to good.	Fair to good.	Fair to good.	High moisture-holding capacity.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
EgB	Egeland-Embden fine sandy loams, undulating.	Poor	Fair to good.	Fair to good.	Fair to good.	High moisture-holding capacity. For gravity system only: topography.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Em	Embden fine sandy loam.	Poor	Good	Good	Good	High moisture-holding capacity.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
En	Embden fine sandy loam, silty substratum.	Poor	Good	Good	Good	Moderately slow permeability in substratum; high moisture-holding capacity.	Waterlogging; wind erosion; drain stability. For gravity system only: distributing water; water erosion.
Es	Exline silt loam	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Very slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Fc	Fargo silty clay	Poor	Poor	Poor to fair.	Poor to fair.	Slow permeability in subsoil and substratum; salinity; high water table.	Waterlogging; salting.
FvA	Fordville loam, level.	Poor	Fair to good.	Fair to good.	Fair to good.	Moderate moisture-holding capacity.	Drain stability; percolation loss.
FvB	Fordville loam, gently sloping.	Poor	Fair to good.	Fair to good.	Fair to good.	Moderate moisture-holding capacity. For gravity system only: topography.	Drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Ga	Gardena loam	Poor	Good	Good	Good	None	None.
GaB	Gardena loam, gently sloping.	Poor	Good	Good	Good	For gravity system only: topography.	For gravity system only: distributing water; water erosion.
Gb	Gardena loam, silty substratum.	Poor	Good	Good	Good	Moderately slow permeability in substratum.	Waterlogging.
Gl	Glyndon silt loam	Poor	Good	Fair to good.	Good	Salinity; high water table.	Waterlogging; salting.
GlB	Glyndon silt loam, gently sloping.	Poor	Good	Fair	Good	Salinity; high water table. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Gm	Glyndon silt loam, saline.	Unsuitable	Poor	Poor to fair.	Fair to good.	Alkalinity; salinity; high water table.	Waterlogging; salting.
Gn	Glyndon silt loam, silty substratum.	Poor	Good	Fair to good.	Good	Slow permeability in substratum; salinity; high water table.	Waterlogging; salting.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
GrB	Great Bend silty clay loam, gently sloping.	Poor	Fair to good.	Good	Good	Moderately slow permeability in subsoil and substratum. For gravity system only: topography.	Waterlogging. For gravity system only: distributing water; water erosion.
Ha	Hamar fine sandy loam.	Poor	Fair	Fair	Fair	High moisture-holding capacity; high water table. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
He	Hamar loamy fine sand.[2]	Poor	Fair	Fair	Good	Moderate moisture-holding capacity; high water table. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Hf	Hamerly loam	Poor	Good	Fair	Good	Moderately slow permeability in substratum; salinity; high water table.	Waterlogging; salting.
Hg	Hamerly-Svea loams.[1]	Unsuitable to poor.	Good	Fair	Good	Moderately slow permeability in substratum; salinity; high water table. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Hh	Hecla fine sandy loam.	Poor	Fair	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Hk	Hecla fine sandy loam, silty substratum.	Poor	Fair	Fair to good.	Fair to good.	Moderately slow permeability in substratum; high moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; waterlogging; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Hl	Hecla loamy fine sand.	Poor	Poor to fair.	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
HlB	Hecla loamy fine sand, gently undulating.	Unsuitable to poor.	Poor	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Hm	Hecla loamy fine sand, silty substratum.	Poor	Poor to fair.	Fair	Fair	Moderately slow permeability in substratum; high moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; water logging; drain stability; percolation loss. For gravity system only: distributing water; water erosion.

See footnotes at end of table.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
Hn	Hecla-Hamar complex.[2]	Unsuitable to poor.	Poor	Fair	Fair	High moisture-holding capacity; high water table. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
HoA	Hecla-Hamar loamy fine sands, level.	Unsuitable to poor.	Poor	Fair	Fair	Moderate moisture-holding capacity; high water table. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
HoB	Hecla-Hamar loamy fine sands, gently undulating.	Unsuitable to poor.	Poor	Fair	Fair	Low moisture-holding capacity; high water table. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
HuA	Hecla-Ulen complex, level.[2]	Unsuitable to poor.	Poor	Fair	Fair	Moderate moisture-holding capacity; high water table. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
HuB	Hecla-Ulen complex, gently undulating.	Unsuitable to poor.	Poor	Fair	Fair	Moderate moisture-holding capacity; high water table. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Hv	Hecla-Ulen fine sandy loams.[2]	Unsuitable to poor.	Fair	Fair to good.	Fair to good.	Moderate moisture-holding capacity; high water table. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Hx	Hegne-Fargo complex, sandy substrata.	Poor	Poor	Poor to fair.	Poor to fair.	Slow permeability in subsoil and upper substratum; salinity; high water table.	Waterlogging; salting.
La	LaDelle silt loam	Poor	Good	Good	Good	Moderately slow permeability in substratum.	Waterlogging.
Lc	LaDelle silty clay loam.	Poor	Good	Good	Good	Moderately slow permeability in substratum.	Waterlogging.
Ld	LaDelle soils, clayey substratum.	Poor	Good	Good	Good	Slow permeability in substratum.	Waterlogging.
Le	Lamoure silty clay loam.	Poor	Fair	Fair to good.	Good	Moderately slow permeability in subsoil and substratum; salinity; high water table.	Waterlogging; salting.
Lf	Lamoure silty clay loam, saline.	Unsuitable to poor.	Poor to fair.	Poor to fair.	Fair	Moderately slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Lg	LaPrairie silt loam.	Poor	Good	Good	Good	Moderate permeability in substratum.	Waterlogging.

See footnotes at end of table.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
Ll	LaPrairie silt loam, channeled.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Moderate permeability in substratum. For gravity system only: topography.	Waterlogging. For gravity system only: distributing water; water erosion.
Lm	LaPrairie and Lamoure soils, channeled.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Moderate and moderately slow permeability in substratum; salinity; high water table. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Ln	Letcher fine sandy loam.	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Poor to fair.	Slow permeability in subsoil; moderate moisture-holding capacity; alkalinity; salinity; high water table.	Waterlogging; salting; drain stability.
Lu	Ludden silty clay	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Poor	Slow permeability in subsoil and substratum; salinity; high water table.	Waterlogging; salting.
Lw	Ludden silty clay, saline.	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Poor	Slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
Ly	Ludden-Ryan silty clays.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Slow to very slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
MaA	Maddock fine sandy loam, level.	Poor	Fair	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
MaB	Maddock fine sandy loam, undulating.	Poor	Fair	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
MbC	Maddock and Barnes soils, rolling.	Unsuitable	Unsuitable	Poor to fair.	Poor to fair.	Moderately slow permeability in substratum; high moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss; waterlogging. For gravity system only: distributing water; water erosion.
McB	Maddock and Hecla fine sands, undulating.	Unsuitable	Unsuitable to poor.	Poor	Poor	Low moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
MhB	Maddock and Hecla loamy fine sands, undulating.	Unsuitable	Fair	Fair	Fair	Low moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
Mk3	Maddock and Hecla soils, severely eroded.	Unsuitable	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Low moisture-holding capacity. For gravity system only; topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
MmB	Maddock-Hecla loamy fine sands, gently undulating.	Unsuitable	Fair	Fair	Fair	Low moisture-holding capacity. For gravity system only: topography; rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Oe	Overly silt loam [1]	Poor	Good	Good	Good	Moderately slow permeability in subsoil and substratum. For gravity system only: topography.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
Pa	Parnell silty clay loam.	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Good	Slow permeability in subsoil and substratum; high water table. For gravity system only: depressed position.	Waterlogging.
Pm	Peat and muck, shallow.	Unsuitable	Unsuitable to poor.	Unsuitable	Good	High water table	Waterlogging; salting.
Pr	Perella loam	Unsuitable to poor.	Good	Poor	Good	Slow permeability in substratum; high water table.	Waterlogging.
Ra	Rauville soils	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Moderately slow permeability in subsoil; salinity; high water table; slow to rapid permeability in substratum.	Waterlogging; salting.
RaC	Rauville soils, sloping.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Moderately slow permeability in subsoil; salinity; high water table. For gravity system only: topography. Slow to rapid permeability in substratum.	Waterlogging; salting. For gravity system only: distributing water; water erosion.
ReA	Renshaw loam, level.	Poor	Fair	Fair	Fair	Moderate moisture-holding capacity.	Drain stability; percolation loss.
ReB	Renshaw loam, gently sloping.	Poor	Fair	Fair	Fair	Moderate moisture-holding capacity. For gravity system only: topography.	Drain stability; percolation loss. For gravity system only: distributing water; water erosion.
RsA	Renshaw and Sioux soils, level.	Poor	Poor to fair.	Poor to fair.	Poor to fair.	Low moisture-holding capacity; shallow to gravel.	Drain stability; percolation loss.
RsB	Renshaw and Sioux soils, gently sloping.	Unsuitable to poor.	Poor	Poor to fair.	Poor to fair.	Low moisture-holding capacity; shallow to gravel. For gravity system only: topography.	Drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Ru	Ryan silty clay	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Very slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.

See footnotes at end of table.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
Ry	Ryan-Ludden silty clays.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Very slow to slow permeability in subsoil and substratum; alkalinity; salinity; high water table.	Waterlogging; salting.
So	Sioux soils	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Very low moisture-holding capacity; shallow to gravel. For gravity system only: topography.	Drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Sp	Spottswood loam [1]	Poor	Fair to good.	Good	Good	High moisture-holding capacity. For gravity system only: topography.	Drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Sr	Stirum fine sandy loam. [2]	Unsuitable	Poor	Poor	Fair	Moderately slow permeability in subsoil; high moisture-holding capacity; alkalinity; salinity; high water table. For gravity system only: rapid infiltration.	Wind erosion; waterlogging; salting; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Ss	Stirum fine sandy loam, very poorly drained.	Unsuitable	Poor	Unsuitable to poor.	Fair	Moderately slow permeability in subsoil; high moisture-holding capacity; alkalinity; salinity; high water table. For gravity system only: rapid infiltration.	Wind erosion; waterlogging; salting; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
St	Stirum-Exline complex.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Moderately slow to very slow permeability in subsoil and substratum; high moisture-holding capacity; alkalinity; salinity; high water table. For gravity system only: rapid infiltration.	Wind erosion; waterlogging; salting; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Su	Stirum-Letcher fine sandy loams.	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Poor to fair.	Moderately slow permeability in subsoil; high moisture-holding capacity; alkalinity; salinity; high water table. For gravity system only: rapid infiltration.	Wind erosion; waterlogging; salting; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Sv	Svea loam	Poor	Good	Good	Good	Moderately slow permeability in substratum; salinity.	Waterlogging; salting.
Sw	Svea-Barnes loams.	Poor	Good	Good	Good	Moderately slow permeability in substratum; salinity.	Waterlogging; salting.
Tf	Tiffany fine sandy loam.	Unsuitable to poor.	Good	Poor	Good	High moisture-holding capacity; high water table. For gravity system only: rapid infiltration.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.

See footnotes at end of table.

TABLE 2.—*Irrigation ratings, limitations, and management problems*—Continued

Map symbols	Soil	Estimated irrigation potential and irrigation ratings				Limitations for gravity and sprinkler systems	Management problems for gravity and sprinkler systems
		Gravity system		Sprinkler system			
		Without drainage or leveling	With drainage or leveling	Without drainage	With drainage		
Tg	Tiffany fine sandy loam, silty substratum.	Unsuitable to poor.	Good	Poor	Good	Moderately slow permeability in substratum; high moisture-holding capacity; high water table. For gravity system only: rapid infiltration.	Wind erosion; waterlogging; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Tn	Tiffany loam	Unsuitable to poor.	Good	Poor	Good	High moisture-holding capacity; high water table.	Drain stability; percolation loss.
Tp	Tonka and Parnell soils.	Unsuitable	Unsuitable to poor.	Unsuitable to poor.	Good	Moderately slow and slow permeability in subsoil and substratum; high water table. For gravity system only: depressed position.	Waterlogging; salting.
Ue	Ulen fine sandy loam.[1]	Poor	Fair to good.	Fair to good.	Good	Moderate moisture-holding capacity; salinity; high water table. For gravity system only: topography.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Uf	Ulen fine sandy loam, silty substratum.	Poor	Fair	Fair to good.	Good	Moderately slow permeability in substratum; high moisture-holding capacity; salinity; high water table.	Wind erosion; waterlogging; salting; drain stability; percolation loss. For gravity system only: distributing water; water erosion.
Uh	Ulen-Hamar complex.[2]	Poor	Fair to good.	Fair to good.	Good	Moderate moisture-holding capacity; salinity; high water table.	Wind erosion; drain stability; percolation loss. For gravity system only: distributing water; water erosion.

[1] Some areas are gently sloping to sloping.

[2] Some areas have a slowly permeable substratum that may cause waterlogging.

The suitability ratings in table 2 are based on soil characteristics. They are defined as follows:

Good: Few if any limitations or management problems.

Fair: Moderate limitations or management problems that require special management.

Poor: Serious limitations or management problems that require intensive management.

Unsuitable: Very serious limitations or management problems that make the soil unsuitable for irrigation.

In table 3 average yields of some of the main irrigated crops are given. These are yields obtained from irrigated test plots of Eckman and Gardena soils on the Ransom Development Farm, 12 miles northeast of Lisbon (*16*) in adjoining Ransom County. The length of the growing season, the temperature, and precipitation at this station are representative of the Survey Area.

TABLE 3.—*Yields of irrigated crops*

Crop	Average yield per acre (1958 to 1964)
Wheat	34. 2 bushels.
Corn for grain	86. 6 bushels.
Corn for silage	19. 0 tons.
Alfalfa hay	5. 2 tons.

In table 4 yields of several irrigated crops are given in terms of a percentage of yields obtained under dryland farming. These are yields from test plots of Eckman, Barnes, and Gardena soils at the Carrington Irrigation Station, 4 miles north of Carrington in adjoining Foster County. At this station, the growing season is shorter, temperatures are lower, and precipitation is less than is

representative of the Survey Area. The dryland yields are from soils left fallow the previous year. The irrigated yields are from soils that are cropped year after year.

TABLE 4.—*Yields of irrigated crops expressed as a percentage of yields under dryland farming*

Crop	1962	1963	1964	Average
	Percent	*Percent*	*Percent*	*Percent*
Hard, red spring wheat	140	111	83	111
Durum wheat	133	96	85	105
Barley	134	96	134	122
Oats	111	92	103	102
Flax		157	143	150
Potatoes	102	238	223	188
Corn for grain	143	281	174	199
Corn for silage		219	152	186

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering purposes.

In the capability system, the kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs:

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use. (No class I soils in La Moure County.)
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat. (No class VII soils in La Moure County.)
- Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass. For some soils, two limitations are of about equal importance, and the subclass symbol indicates both, for example, IIwe-4.

In the following pages the capability units in La Moure County and parts of James River Valley are described, and suggestions for the use and management of the soils are given.

The names of the soil series represented are mentioned in the description of each capability unit, but the listing of the series name does not necessarily indicate that all the soils of a series are in the same capability unit. The capability classification of any given soil can be learned by referring to the "Guide to Mapping Units."

In this Survey Area, the capability units are set up and numbered within a system of capability classification that is used throughout the State of North Dakota. Not all the capability units in this system are applicable, and for this reason the numbering of the capability units is not consecutive in all cases.

CAPABILITY UNIT IIc-6

This unit consists of deep, dark-colored, well drained and moderately well drained soils of the Barnes, Cres-

bard, Eckman, Edgeley, Gardena, Great Bend, LaDelle, LaPrairie, Overly, and Svea series. These soils occur on uplands, stream terraces, and bottom lands. They have a surface layer of loam, silt loam, clay loam, or silty clay loam that is 20 to 35 percent clay.

The root zone is deep, and roots can penetrate easily. Permeability is moderate. The moisture-holding capacity is high, and the organic-matter content is high. Tillage is easy. Erosion is a slight hazard.

All the crops commonly grown in this Area are well suited. Spring wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Trees and tame grasses are also well suited.

The chief management problems are maintenance of organic-matter content and fertility, improvement of tilth, and conservation of moisture. Crop production is limited mainly by lack of moisture and the short growing season. Use of crop residue and manure and inclusion of grasses and legumes in the cropping system help to maintain organic-matter content. The application of nitrogen and phosphorus also helps to maintain fertility. Summer fallow, minimum tillage, and weed control are practices that help to conserve moisture. The use of rough tillage, standing stubble, and single-row tree belts to trap snow provides additional moisture for crops.

CAPABILITY UNIT IIe-4

This unit consists of deep, fine-textured, level to gently sloping soils of the Fargo and Nutley series. These soils occur on uplands. They have a surface layer and subsoil of silty clay, and they have good surface drainage.

The root zone is deep, and roots can penetrate easily. Permeability is slow. The moisture-holding capacity is high, and moisture is readily released to plants. The organic-matter content is high, and the natural fertility is high.

These soils slake down to sand-sized particles when they are fall plowed. They are moderately susceptible to wind erosion, especially in winter and early in spring. The more sloping areas are moderately susceptible to water erosion.

All the crops commonly grown in this Area can be produced. Small grain, flax, and alfalfa are better suited than other common crops. Trees and tame grasses are also well suited. Corn can be grown, but there is some danger of frost damage before it reaches maturity.

The chief management problems are control of erosion, maintenance of organic-matter content and fertility, improvement of tilth, and conservation of moisture. Fertility can be kept up and organic-matter content can be maintained by including grass and legume mixtures in the cropping system, using crop residue and manure, and applying nitrogen and phosphorus.

If these soils are tilled when they are too wet, they become hard and cloddy as they dry. Summer fallow, minimum tillage, and weed control are practices that help to conserve moisture. If the cropping system includes summer fallow, stubble-mulch tillage should be used to conserve moisture and control erosion.

CAPABILITY UNIT IIe-4L

This unit consists of deep, moderately well drained, medium-textured soils of the Bearden, Glyndon, Hamerly, and Svea series. These soils occur on glacial till plains, lake plains, and terraces. They are nearly level to gently sloping and have a high content of lime. Included are smaller areas of closely associated, deep, medium-textured, moderately well drained, nonlimy soils.

These soils have a deep root zone, and they are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. The moisture-holding capacity is high. Tillage is easy.

The surface layer slakes down readily to sand-sized particles. When slaking occurs, the soils are moderately to highly susceptible to wind erosion.

These soils are well suited to all the crops commonly grown. Spring wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops.

The chief management problems are control of erosion, maintenance of organic-matter content and fertility, improvement of tilth, and conservation of moisture. Stubble-mulch tillage, conserving crop residue, stripcropping, and establishing windbreaks help to control wind erosion. Including alfalfa and tame grasses in the cropping system and applying nitrogen and phosphorus are practices that maintain organic-matter content and the supply of plant nutrients and improve tilth. Summer fallow is not a suitable practice, because it increases the accumulation of lime in the surface layer.

CAPABILITY UNIT IIe-5

This unit consists of deep, well drained and moderately well drained, level to undulating soils of the Egeland, Embden, and Gardena series. These soils occur on uplands. The surface layer is medium textured, and the subsoil is moderately coarse textured to medium textured. The clay content of the surface layer is less than 20 percent.

These soils have a deep root zone, and they are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. The moisture-holding capacity is low in the subsoil. Wind erosion is a moderate hazard.

The soils are well suited to all the crops commonly grown. Wheat, oats, barley, rye, corn, and alfalfa are the main crops. Trees and tame grasses are also well suited.

The chief management problems are control of wind erosion, maintenance of fertility, and conservation of moisture. The organic-matter content can be maintained by including legumes and grasses in the cropping system, and the supply of plant nutrients can be improved by the application of nitrogen and phosphorus. The conservation of crop residue helps to maintain the organic-matter content and to protect the soils from erosion. Other practices that help to control wind erosion are stripcropping, establishing windbreaks, stubble mulching, and using winter cover crops. Summer fallow stores moisture for the succeeding crop, but it increases the hazard of wind erosion.

CAPABILITY UNIT IIe-6

This unit consists of deep, medium-textured and moderately fine textured, well-drained, undulating soils of the Barnes, Eckman, Edgeley, Gardena, Great Bend, LaPrairie and Svea series. Most of these soils occur on glacial till plains, but some are on side slopes and bottom lands in the James River Valley. They have a surface layer and subsoil of loam, silt loam, and clay loam.

These soils have a deep root zone, and are readily permeable to roots, air, and moisture. They are well supplied

with organic matter and plant nutrients. The moisture-holding capacity is high. When the soils are bare, cultivated fields are moderately susceptible to water erosion during intense rains. Cultivated areas are also moderately susceptible to wind erosion before vegetation is established in spring.

These soils are well suited to all the crops commonly grown. Spring wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Trees and tame grasses are also well suited.

The chief management problems are control of erosion, maintenance of organic-matter content and fertility, and conservation of moisture. Inclusion of grasses and legumes in the cropping system and management of crop residue help to maintain organic-matter content. Applications of nitrogen and phosphorus increase the supply of available plant nutrients. Stubble-mulch tillage, establishing windbreaks, and stripcropping help to conserve moisture and control erosion. Summer fallow and weed control also help to conserve moisture.

CAPABILITY UNIT IIwe–4

This unit consists of deep, poorly drained, fine-textured, level soils of the Fargo, Hegne, and Ludden series. These soils occur on lake plains and bottom lands.

These soils have a deep root zone, and roots can penetrate easily. They are slowly permeable to air and water. The moisture-holding capacity is high. The supply of organic matter and plant nutrients is good. Tillage is rather difficult because of the high content of clay.

These soils are occasionally flooded after heavy rains because runoff is slow and internal drainage is restricted. They slake down to sand-sized particles when they are fall plowed and become moderately susceptible to wind erosion.

All the crops commonly grown are well suited, but wheat and other small grain are especially well suited. Trees and grasses are also well suited. If cultivated when too wet, the soils become hard and cloddy as they dry.

The chief management problems are control of wetness and erosion and maintenance of tilth. Surface drainage can be improved by constructing drainage ditches. Wind erosion can be controlled by stubble-mulch tillage, establishing windbreaks, stripcropping, and using cover crops. Permeability and tilth can be improved by including alfalfa or sweetclover in the cropping system. Response to nitrogen and phosphorus is generally good.

CAPABILITY UNIT IIw–4L

This unit consists of deep, poorly drained, medium-textured and moderately fine textured soils of the Borup, Colvin, Lamoure, and Vallers series. These soils occur on bottom lands, in outwash channels, and in shallow upland depressions. They have a high content of lime.

The root zone is deep. The supply of organic matter and plant nutrients is good. Tillage is easy.

These soils have a seasonally high water table. They are moderately to highly susceptible to wind erosion because they slake down readily to sand-sized particles. Undrained areas are usually too wet to cultivate.

Drained areas are well suited to all the crops commonly grown. Small grain, corn, flax, and tame grasses are the main crops. Trees are also well suited. Undrained areas are used mainly for hay and pasture.

The chief management problem in cultivated areas is control of wetness. Wind erosion can be controlled by management of crop residue, use of stubble-mulch tillage, and use of a winter cover crop. Applications of phosphorus and nitrogen and including sweetclover in the cropping system help to maintain the organic-matter content and keep up fertility.

CAPABILITY UNIT IIw–6

This unit consists of deep, dark-colored, medium-textured and moderately fine textured soils of the Parnell, Perella, Tonka, and Tiffany series. These soils occur in shallow, closed depressions on uplands. They are poorly drained and are intermittently ponded by runoff from higher lying soils. The excess water can be removed by surface drainage.

The root zone is deep, and roots can penetrate easily. The moisture-holding capacity is high. Permeability to air and moisture is slow to moderate. These soils contain a large amount of organic matter and are well supplied with plant nutrients. Tillage is easy when the soils are dry. Erosion is not a problem.

Drained areas are well suited to all the crops commonly grown. Wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Trees and tame grasses are also well suited. Undrained areas are used mainly for small grain, flax, and millet, which can be planted late in the season. Some areas are used for native pasture and hay.

The chief limitation is water that ponds on the surface after rapid snowmelt or heavy rainfall. Surface drainage is effective wherever there are satisfactory outlets. Drained areas are tilled and seeded along with surrounding areas of well-drained upland soils. In many years undrained areas are tilled 1 to 3 weeks later than surrounding soils. Crops are occasionally damaged by wetness.

CAPABILITY UNIT IIIe–3

This unit consists of deep, moderately well drained and well drained, nearly level to sloping soils of the Embden, Egeland, Hamar, Hecla, Maddock, and Ulen series. These soils occur on uplands. They have a surface layer of fine sandy loam and a subsoil of loamy fine sand or fine sandy loam. The material at a depth of about 20 to 36 inches ranges from loamy fine sand to silt loam.

These soils have a deep root zone, and they are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. They are highly susceptible to wind erosion if they are cultivated and not protected. The moisture-holding capacity is moderate to low. Tillage is easy.

These soils are well suited to all the crops commonly grown. Wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Trees and tame grasses are also well suited.

The chief management problems are control of erosion, maintenance of organic-matter content and fertility, and conservation of moisture. Stubble-mulch tillage, stripcropping, and establishing windbreaks are practices that help to control erosion and conserve moisture. Inclusion of grasses and legumes in the cropping system and management of crop residue help to maintain the organic-matter content. Application of nitrogen and phosphorus

keeps up fertility. Summer fallow is not a suitable practice.

CAPABILITY UNIT IIIe-3P

The only soil in this unit is Letcher fine sandy loam. This is a nearly level soil that has a claypan subsoil. It occurs as nearly level areas and slight depressions on glacial lake plains.

This soil has a moderately deep root zone. It is somewhat droughty and is highly susceptible to wind erosion when cultivated and not protected. The surface layer is readily permeable to roots, air, and moisture. The subsoil is only slowly permeable, however, and there are salts in the lower part. The moisture-holding capacity is low. Tillage is easy.

This soil is suited to all the crops commonly grown in the Area. Small grain, flax, alfalfa, and corn are the main crops.

The chief management problems are control of wind erosion and maintenance of organic-matter content and fertility. Stubble-mulch tillage and stripcropping help to control erosion. Windbreaks are not commonly used, because the soil is poorly suited to trees. The organic-matter content can be maintained by including grass and legume mixtures in the cropping system, adding manure and returning crop residue, and applying phosphorus and nitrogen. Summer fallow is not a common practice, because of the risk of erosion and the low moisture-holding capacity.

CAPABILITY UNIT IIIe-6

This unit consists of deep, dark-colored soils of the Barnes, Buse, Eckman, and Renshaw series. These are well-drained, medium-textured soils on rolling uplands.

These soils have a deep root zone, and they are readily permeable to roots, air, and moisture. They are well supplied with organic matter, except in areas where most of the surface layer has been lost through erosion. They are highly susceptible to water erosion; during periods of intense rainfall and rapid snowmelt, the soil is washed from hilltops and upper slopes.

These soils are suited to all the crops commonly grown. Spring wheat, oats, barley, rye, flax, and alfalfa are the main crops. Corn is not generally grown, because of the risk of erosion. Trees and tame grasses are well suited.

The chief management problems are control of erosion, conservation of moisture, and maintenance of organic-matter content and fertility. Stubble-mulch tillage, use of winter cover crops, and management of crop residue help to control erosion. Contour cultivation is not practical in most places, because the soils are generally on short, irregular slopes. Summer fallow and stubble-mulch tillage help to store moisture for the succeeding crop. The organic-matter content can be maintained by including grass and legumes in the cropping system, adding manure, and returning crop residue. Fertility can be kept up by applying nitrogen and phosphorus.

Some fairly large areas are used for pasture. Some of the pasture consists of native grasses, such as little bluestem, green needlegrass, side-oats grama, and blue grama. Others have been seeded to bromegrass, crested wheatgrass, and other tame grasses.

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CAPABILITY UNIT IIIes-3

This unit consists of moderately deep, well-drained, moderately coarse textured, nearly level to sloping soils of the Arvilla and Claire series. These soils are moderately deep to coarse sand and gravel. They occur on uplands and terraces.

These soils have a moderately deep root zone, and they are readily permeable to roots, air, and moisture. They are moderately well supplied with organic matter and plant nutrients. The moisture-holding capacity is low. Tillage is easy. Wind erosion is a severe hazard if the soils are cultivated and not protected.

Small grain, flax, corn, and alfalfa are suitable crops. Trees and tame grasses are fairly well suited.

The chief management problems are control of erosion, conservation of moisture, and maintenance of organic-matter content and fertility. Practices that help to control erosion and conserve moisture include management of crop residue, stripcropping, establishing windbreaks, and stubble-mulch tillage. The organic-matter content can be maintained by including grass and legume mixtures in the cropping system, applying manure, and conserving crop residue. Fertility can be kept up by applying nitrogen and phosphorus. Summer fallow is seldom used for conservation of moisture because of the low moisture-holding capacity and the risk of wind erosion.

CAPABILITY UNIT IIIes-5

This unit consists of well-drained, medium-textured, gently sloping soils of the Fordville and Renshaw series. These soils are underlain by coarse sand or gravel at a depth of about 16 to 36 inches. They occur on outwash plains and terraces. They have a surface layer of loam and a subsoil of clay or clay loam.

These soils have a moderately deep root zone, and they are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. The moisture-holding capacity is moderate to low. Wind erosion is a hazard. Tillage is easy.

Suitable crops are small grain, corn, flax, and alfalfa. Trees are fairly well suited.

The chief management problems are control of erosion and conservation of moisture. Stubble-mulch tillage, stripcropping, and establishing field windbreaks help to control erosion and conserve moisture. Management of crop residue also helps to control erosion. Frequent inclusion of grasses and legumes in the cropping system helps to maintain the organic-matter content, check erosion, and improve tilth. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IIIwe-3

This unit consists of deep, moderately coarse textured, poorly drained soils of the Arveson, Hamar, and Tiffany series. These soils occur as shallow depressions on uplands. They have a water table that is within 3 feet of the surface throughout most of the growing season. They are occasionally ponded after rapid snowmelt or heavy rainfall.

These soils are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. Tillage is easy when the soils are dry.

These soils are suitable for most crops commonly grown in the Area. Wheat, oats, barley, rye, flax, corn, and

alfalfa are the main crops. Trees and tame grasses are also suitable.

The chief management problems are improvement of drainage and control of wind erosion. Wetness can be corrected by drainage if enough outlets are available. Small grain, corn, millet, and flax are crops that can be planted late in the season in years when wetness delays planting. Wind erosion can be controlled by stubble-mulch tillage, use of cover crops, stripcropping, and establishing windbreaks. The water table can be lowered and the supply of organic matter increased by frequent inclusion of alfalfa and sweetclover in the cropping system. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IIIs–4

This unit consists of deep, medium-textured to fine-textured, level soils of the Bearden, Glyndon, and Ludden series. These soils occur on lake plains and bottom lands. They contain enough soluble salts to be harmful to crops. The surface layer is silt loam, silty clay loam, or silty clay. It is underlain by loam to silty clay.

The root zone is deep. Permeability is moderate to slow. The supply of organic matter and plant nutrients is moderate.

Salt-tolerant crops, such as barley, rye, oats, wheat, sweetclover, and alfalfa, are suitable. Corn and flax are less well suited. Trees are poorly suited.

The chief management problems are control of salinity, improvement of drainage, and maintenance of organic-matter content, fertility, and tilth. The water table can be lowered and the salt accumulation within the root zone reduced by including alfalfa and sweetclover in the cropping system. Manure and crop residue should be plowed down to increase the organic-matter content. Stubble-mulch tillage reduces evaporation and the upward movement of salts. Application of phosphorus and nitrogen increases the supply of plant nutrients. Summer fallow should be avoided because this practice favors a rise in the water table and increases surface evaporation and salt accumulation.

CAPABILITY UNIT IIIs–4L

This unit consists of Divide loam, a limy soil that is underlain by coarse sand and gravel at a depth of about 24 to 36 inches. This soil is nearly level and moderately well drained to somewhat poorly drained. The surface layer is loam. It is underlain by sandy loam to silt loam.

This soil has a moderately deep root zone, and it is readily permeable to roots, air, and water. It is well supplied with organic matter and plant nutrients. The moisture-holding capacity is moderate. Wind erosion is a moderate hazard. The water table is seasonally at a depth of 3 feet or more.

This soil is well suited to all the crops commonly grown. Wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Trees are well suited.

The chief management problems are conservation of moisture, control of wind erosion, and maintenance of organic-matter content and fertility. Management of crop residue, stripcropping, and establishing field windbreaks are practices that help to conserve moisture and control erosion. Frequent inclusion of grasses and legumes in the cropping system increases the organic-matter content and improves tilth. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IIIs–4P

This unit consists only of Ludden-Ryan silty clays. Both soils have a claypan. They occur on bottom lands.

The Ludden soil has a deep root zone. It is readily penetrated by roots, but it is slowly permeable to air and water. The Ryan soil has a shallow root zone. This soil is slowly permeable to roots, air, and water. It is strongly alkaline and contains a large amount of soluble salts in the lower part of the subsoil.

This complex is used for crops and for hay and pasture. Barley, rye, oats, wheat, sweetclover, and alfalfa are suitable. Trees are poorly suited, but some are planted for farmstead windbreaks. If these soils are tilled when they are too wet, they become crusted and cloddy as they dry.

The chief management problems in using these soils for crops are maintenance of tilth and selection of salt-tolerant crops. Management of crop residue and application of manure help to maintain the organic-matter content and to improve the physical condition of the soils. Inclusion of alfalfa and sweetclover in the cropping system helps to preserve soil structure and improves permeability and tilth. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IIIs–5

This unit consists of medium-textured, level soils of the Fordville, Renshaw, and Spottswood series. These soils are underlain by coarse sand and gravel at a depth of about 16 to 36 inches. They occur on outwash plains and terraces. They have a surface layer of loam and a subsoil of loam or clay loam.

These soils have a moderately deep root zone, and they are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. The moisture-holding capacity is moderate to low. Tillage is easy. Wind erosion is a hazard.

These soils are suited to all the crops commonly grown. Wheat, oats, barley, rye, flax, corn, and alfalfa are the main crops. Trees for field and farmstead windbreaks are fairly well suited.

The chief management problems are conservation of moisture and control of wind erosion. Stubble-mulch tillage, stripcropping, and establishing field windbreaks help to conserve moisture and control erosion. Management of crop residue and frequent inclusion of grasses and legumes in the cropping system help to maintain the organic-matter content and improve tilth. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IIIs–6P

This unit consists of complexes of deep, medium-textured soils and soils that are moderately deep and shallow to a claypan. These soils are members of the Aberdeen, Barnes, Bearden, Cavour, Cresbard, Exline, and Overly series. They occur as level areas on uplands and terraces.

Permeability of these soils to roots, air, and water ranges from moderate in the deep, medium-textured soils to slow in the soils that are shallow to a claypan. The deep soils are easily tilled, but the claypan soils are difficult to till. These soils are well supplied with organic

matter and plant nutrients. The claypan soils are strongly alkaline, and they contain a large amount of soluble salts in the lower part of the subsoil. Erosion is not a serious problem.

Small grain, alfalfa, and tame grasses are suitable crops. Trees are poorly suited, but some are planted for farmstead windbreaks.

The chief management problems are maintenance of organic-matter content, fertility, and tilth and conservation of moisture. Frequent inclusion of alfalfa, sweetclover, and tame grasses in the cropping system helps to maintain organic-matter content, preserve soil structure, and improve permeability and tilth. Stubble-mulch tillage and management of crop residue help to conserve moisture. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IIIws-3

This unit consists of moderately coarse textured, poorly drained, alkali soils of the Letcher and Stirum series. These soils have a high content of lime. They occur as nearly level areas and slight depressions on lake plains. They have a surface layer of fine sandy loam and a subsoil that has a high content of sodium. The sodium causes dispersion of soil particles. Dispersed soils are likely to slick over when wet and to crust when dry. The water table rises nearly to the surface after heavy rainfall or rapid snowmelt.

These soils contain a good supply of organic matter, but the high salt content limits plant growth. Roots do not penetrate deeply into the subsoil. The moisture-holding capacity is low. Wind erosion is a severe hazard.

Salt-tolerant crops, such as barley, rye, oats, wheat, sweetclover, and alfalfa, are suitable. Trees are poorly suited.

The chief management problems are improvement of drainage, control of salinity and erosion, and maintenance of organic-matter content, fertility, and tilth. Frequent inclusion of deep-rooted legumes and grasses in the cropping system helps to lower the water table and limit salt accumulation in the root zone. Stubble-mulch tillage, management of crop residue, and application of manure and fertilizer help to control erosion and maintain tilth and fertility. Surface drainage is practicable in areas where outlets are available.

CAPABILITY UNIT IIIws-4

This unit consists of deep, poorly drained, moderately saline soils of the Colvin and Lamoure series. These soils occur on lake plains and bottom lands. They have a surface layer of silt loam or silty clay loam. A high water table keeps the soils wet throughout most of the growing season.

These soils are well supplied with organic matter and plant nutrients, but they contain enough soluble salts to affect plant growth. The salts restrict the penetration of roots and limit the kind of plants that can grow.

Drained areas are suitable for barley, rye, oats, wheat, sweetclover, and alfalfa. Undrained areas are better suited to hay and pasture. They are generally used for native grasses, mainly Nuttall alkaligrass, inland saltgrass, western wheatgrass, slender wheatgrass, and plains bluegrass. Control of grazing helps to improve the stands of native grasses. Trees are poorly suited.

The chief management problems are improvement of drainage and control of salinity. Frequent inclusion of deep-rooted legumes, such as sweetclover and alfalfa, in the cropping system helps to lower the water table and limit salt accumulation in the root zone.

CAPABILITY UNIT IVe-2

This unit consists of deep, level to undulating, coarse-textured soils of the Hamar, Hecla, Maddock, and Ulen series. These soils are somewhat poorly drained to well drained. They have a surface layer and subsoil of loamy fine sand.

These soils have a deep root zone, and they are readily permeable to roots, air, and water. They are easily worked, but they have low moisture-holding capacity. They are well supplied with organic matter and plant nutrients. Wind erosion is a severe hazard.

All the crops commonly grown are suitable. The main crops are wheat, oats, barley, rye, flax, corn, and alfalfa. Trees for farmstead and field windbreaks are well suited.

The chief management problems are control of wind erosion, conservation of moisture, and maintenance of organic-matter content and fertility. These soils are not fall plowed or summer fallowed, because of the hazard of wind erosion. They are usually plowed, packed, and seeded in one operation in spring. Other practices that help control erosion, maintain organic-matter content, and conserve moisture are management of crop residue, stubble-mulch tillage, stripcropping, and establishing field windbreaks. Frequent inclusion of grasses and legumes in the cropping system helps to maintain the supply of organic matter. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IVe-3

This unit consists of Maddock and Barnes soils, rolling. These are deep, well-drained, moderately coarse textured and medium-textured soils on uplands. They are underlain by glacial till at a depth of 1 to 4 feet. In most places the surface layer is sandy loam.

These soils have a deep root zone, and they are readily permeable to roots, air, and water. They are well supplied with organic matter and plant nutrients. They are somewhat droughty and are highly susceptible to wind and water erosion.

These soils are suitable for cultivated crops if erosion is controlled. Small grain, flax, and alfalfa are better suited than other crops. Corn is poorly suited. Trees are fairly well suited.

The chief management problems are control of erosion, conservation of moisture, and maintenance of organic-matter content and fertility. Stubble-mulch tillage and conservation of crop residue help to control erosion and conserve moisture. Frequent inclusion of grasses and legumes in the cropping system helps to maintain the organic-matter content. These soils generally respond to applications of nitrogen and phosphorus.

CAPABILITY UNIT IVe-6

This unit consists of Barnes-Buse loams, hilly. These are deep, medium-textured soils on hilly uplands and valley side slopes. They have a thin to moderately thick surface layer.

These soils have a deep root zone, and they are moderately permeable to roots, air, and moisture, but water

runs off rapidly because of the slope. The organic-matter content and the supply of plant nutrients are moderately low. Water erosion is a severe hazard in cultivated areas.

These soils are poorly suited to row crops, because of the erosion hazard. They are better suited to small grain, alfalfa, and tame grasses. Trees for farmstead windbreaks are fairly well suited.

The chief management problems are control of water erosion, conservation of moisture, and maintenance of organic-matter content and fertility. Stubble-mulch tillage, management of crop residue, frequent inclusion of grass and legumes in the cropping system, and use of winter cover crops are some of the practices that help to control erosion and conserve moisture. Application of nitrogen and phosphorus keeps up fertility.

CAPABILITY UNIT IVsw-6

This unit consists of Loamy lake beaches. The soil material is moderately coarse textured to medium textured and is somewhat poorly drained. The areas are nearly level to sloping. Some areas are moderately stony.

The root zone is deep. The organic-matter content is low, and natural fertility is low. The areas are intermittently ponded because the adjoining lakes overflow. The hazard of flooding and the low supply of plant nutrients limit the use of these areas for cultivated crops.

Most of the acreage is used for pasture, but some of the more nearly level areas are used for crops. Small grain is the principal crop. Trees are poorly suited, but there are a few cottonwoods. Native grasses consist mainly of big bluestem, little bluestem, switchgrass, and prairie cordgrass. Applications of nitrogen and phosphorus are beneficial.

CAPABILITY UNIT Vw-WL

This unit consists of deep, very poorly drained soils of the Arveson, Borup, Colvin, Grano, Parnell, Perella, Rauville, Stirum, and Venlo series and of Peat and muck, shallow. These soils occur in depressions and on lowlands. The water table is at or near the surface throughout most of the growing season, and the areas are frequently flooded.

These soils are well supplied with organic matter and plant nutrients. Roots penetrate easily, but the movement of air through the soils is restricted by wetness. Erosion is not a problem.

Drainage is not practicable, and wetness makes these soils unsuitable for cultivated crops. Hay, pasture, and wildlife habitat are suitable uses. Most areas support dense stands of rivergrass, slough sedge, American mannagrass, northern reedgrass, prairie cordgrass, and a few cattails and rushes. Grazing should be restricted when the soils are excessively wet because the soils puddle when trampled. Forage can be improved by seeding reed canarygrass in areas where vegetation is sparse.

CAPABILITY UNIT VIe-Sa

This unit consists of deep, coarse-textured, nearly level to hummocky soils of the Hecla and Maddock series. The soils are severely eroded.

These soils are readily permeable to roots, air, and water. The moisture-holding capacity is low, and the soils are extremely droughty. The organic-matter content is low. Wind erosion is a severe hazard.

These soils are not suited to cultivated crops, but they can be used for hay and pasture. Most areas are in native grasses, mainly prairie sandreed, needle-and-thread, sand bluestem, Canada wildrye, and sand dropseed. Some areas are bare of vegetation.

The chief management need is maintenance of an adequate vegetative cover by reseeding where necessary and by regulating grazing. Overgrazing favors the spread of less desirable grasses and weeds and increases the hazard of wind erosion. Timely mowing helps keep down weeds and other undesirable plants.

CAPABILITY UNIT VIe-Si

This unit consists of LaPrairie and Lamoure soils, channeled. These are deep, medium-textured soils on bottom lands. They are so highly dissected by old channels and oxbows that they cannot be crossed with farm machinery.

These soils have a deep root zone, and they are readily permeable to roots, air, and water. They are well supplied with organic matter and plant nutrients. The moisture-holding capacity is high.

Most areas are used for native pasture and hay. Some areas along the James River support dense stands of trees and brush. In the channels the native grasses are big bluestem, switchgrass, and slender wheatgrass. On bottom lands the grasses are mainly green needlegrass, bearded wheatgrass, and western wheatgrass.

The chief management need is maintenance of a high-quality vegetative cover. Good range management practices, such as proper stocking, deferred grazing, proper distribution of grazing, and proper seasonal use, help to increase the production of desirable grasses. Mowing or spraying helps to keep down weeds and undesirable plants.

CAPABILITY UNIT VIe-Tsi

This unit consists of Buse-Barnes loams, steep. These are deep, medium-textured soils that have a thin surface layer.

These soils are readily permeable to roots, air, and water. They are somewhat droughty. The organic-matter content and the supply of plant nutrients are moderately low. Runoff is rapid.

These soils are not suited to cultivation, because they are steep and highly susceptible to water erosion. They are better suited to native pasture and hay. Most areas are in native grass, but a few scattered areas have been broken up in an effort to use them for production of small grain. The dominant native grasses are little bluestem, needle-and-thread, plains muhly, side-oats grama, and blue grama.

The chief management need is to maintain a vegetative cover of high-quality forage. Areas that have been cultivated should be reseeded to suitable tame and native grasses. Good range management practices, such as proper stocking, deferred and rotation grazing, and proper seasonal use, help to increase the vigor and productivity of established stands of native grasses. Mowing or spraying helps to keep down weeds and undesirable plants.

CAPABILITY UNIT VIs–Si

This unit consists of Barnes stony loam, an undulating to rolling soil on uplands and terraces. This soil is too stony to be worked with tillage implements. Most areas are deep and medium textured, but included are small areas of sandy soils and shallow soils underlain by gravel.

This soil is readily permeable to air, moisture, and plant roots. Most areas are well supplied with organic matter and plant nutrients.

This soil is not suited to cultivation, because it is too stony. It is poorly suited to hay because stones interfere with haying operations. It is well suited to pasture, and all the acreage is used for native grasses. The main grasses are green needlegrass, bearded wheatgrass, western wheatgrass, needle-and-thread, and blue grama.

The chief management need is to maintain a vegetative cover of high-quality forage. Good range management practices, such as proper stocking, deferred and rotation grazing, and proper seasonal use help to improve the vigor and productivity of the native grasses. Control of grazing allows the more desirable grasses to increase and keeps down weeds and undesirable plants.

CAPABILITY UNIT VIs–SS

This unit consists of level, saline and saline-alkaline soils of the Cavour, Exline, Lamoure, Ludden, Ryan, and Stirum series and of Saline land. These soils occur on bottom lands, low stream terraces, and glaciated uplands. They have a thin to moderately thick surface layer. The Cavour, Exline, Ryan, and Stirum soils have a dense claypan subsoil. They are somewhat poorly drained to poorly drained. The water table is seasonally high; it rises to the lower part of the subsoil.

These soils are slowly permeable to air, moisture, and roots. They are fairly well supplied with organic matter and plant nutrients, but they have a high concentration of soluble salts.

These soils are not suited to cultivated crops, because of their high salt content. They are better suited to hay and pasture. The main native grasses are Nuttall alkaligrass, inland saltgrass, western wheatgrass, slender wheatgrass, and plains bluegrass. Although these soils are not suitable for crops, a few areas are used for small grain. In cultivated areas tillage brings material from the claypan into the plow layer, and the surface becomes hard and cloddy when dry and sticky when wet. Trees are poorly suited, but some have been planted for farmstead windbreaks.

The chief management need is to maintain a vegetative cover that produces the largest amount of high-quality forage. Good range management practices, such as proper stocking, deferred and rotation grazing, and proper seasonal use, help to improve the stands of native grasses. Cultivated areas should be reseeded to suitable tame and native grasses. Mowing and control of grazing help to keep down weeds and undesirable plants.

CAPABILITY UNIT VIs–SwG

This unit consists of level to steep soils of the Renshaw and Sioux series. These soils are shallow to coarse sand and gravel. They have a surface layer of sandy loam, gravelly loam, or loam, and the depth to gravel ranges from 6 to 16 inches.

These soils are readily permeable to air and moisture, but they have low moisture-holding capacity. The root zone is shallow.

These soils are not suited to cultivated crops. They are better suited to native hay and pasture, and most of the acreage is used for these crops. The main native grasses include needle-and-thread, blue grama, needleleaf sedge, and western wheatgrass. Although these soils are not suitable for crops, a few areas are cultivated. Trees are poorly suited, but a few are planted for farmstead windbreaks.

The chief management need is to maintain a vegetative cover that produces the largest amount of high-quality forage. Good range management practices, such as proper stocking, deferred and rotation grazing, and proper seasonal use, help to improve the stands of native grasses. Cultivated areas should be reseeded to suitable tame and native grasses. Mowing and control of grazing help to keep down weeds and undesirable plants.

CAPABILITY UNIT VIIIw–1

This unit consists of Fresh water marsh. These areas are under water most of the time. They have no agricultural value, but they provide an excellent habitat for waterfowl. The vegetation consists mainly of cattails, bulrushes, reeds, and other aquatic plants.

Estimated yields

Table 5 gives estimated yields per acre of important crops grown in this Survey Area under two levels of management. The estimates in columns A are yields to be expected under average management. Those in columns B are yields that can be expected under improved management.

Under average management suitable crop varieties are seeded at the proper time and rate, and the crops are protected from weeds, insects, and disease. The use of commercial fertilizer and chemicals for weed control is limited.

Under average management the cropping sequence on medium-textured, moderately fine textured, and fine textured soils generally consists of 2 to 3 years of small grain, 1 year of corn or summer fallow, and an occasional seeding of grasses and legumes. The same general crop rotation is used on coarse textured and moderately coarse textured soils, except that summer fallow is not used. Average management includes few, if any, erosion control practices, and it does not include adequate drainage on wet soils.

Under improved management farmers make more intensive use of erosion control and moisture conservation practices, such as stubble-mulch tillage, management of crop residue, stripcropping, establishing field windbreaks and buffer strips, and growing cover crops. Also, grasses and legumes are included in crop rotations more frequently. In addition, commercial fertilizer is applied regularly according to the results of soil tests.

The estimates given in the table are based on records kept by farmers, on data developed at the Agricultural Experiment Station at Edgeley, and on information obtained in interviews with farmers and other informed persons.

TABLE 5.—*Estimated average yields per acre of principal crops under two levels of management*

[Columns A list yields to be expected under average management, and columns B list yields that can be obtained under improved management. Absence of a yield figure indicates that the crop is not suitable or ordinarily is not grown]

Soil	Wheat		Barley		Oats		Corn		Tame hay	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Aberdeen silt loam	14	18	20	26	28	36	20	26	1.2	1.5
Aberdeen-Exline complex	10	12	14	18	20	24	—	—	1.1	1.3
Arveson fine sandy loam [1]	14	18	20	24	28	36	26	32	1.2	1.6
Arveson fine sandy loam, very poorly drained	—	—	—	—	—	—	—	—	—	—
Arvilla sandy loam, level	8	11	12	16	17	22	14	18	.8	1.0
Arvilla sandy loam, undulating	8	11	12	16	17	22	14	18	.8	1.0
Barnes loam, rolling	14	18	24	30	28	36	—	—	1.0	1.4
Barnes loam, rolling, eroded	13	18	23	30	26	34	—	—	1.0	1.4
Barnes stony loam	—	—	—	—	—	—	—	—	—	—
Barnes-Buse loams, rolling	13	18	20	26	26	36	—	—	.9	1.4
Barnes-Buse loams, hilly	10	12	14	18	20	26	—	—	.8	1.0
Barnes-Cresbard loams	18	24	27	34	36	46	28	36	1.5	2.0
Barnes, Gardena, and Eckman loams, level	22	28	32	40	40	50	30	38	1.6	2.1
Barnes-Renshaw loams, rolling	12	15	20	25	26	34	—	—	1.0	1.2
Barnes-Svea loams, undulating	18	24	27	34	36	46	28	36	1.5	2.0
Bearden silt loam	18	24	32	40	40	50	30	40	1.5	2.0
Bearden silt loam, saline	14	16	20	24	25	32	—	—	1.0	1.5
Bearden-Exline complex	12	15	24	30	28	36	20	24	1.2	1.5
Borup silt loam [1]	18	24	28	34	36	46	30	38	1.5	2.0
Borup silt loam, very poorly drained	—	—	—	—	—	—	—	—	—	—
Buse-Barnes loams, steep	—	—	—	—	—	—	—	—	—	—
Cavour complex	—	—	—	—	—	—	—	—	—	—
Claire sandy loam	8	10	12	16	17	22	14	18	.8	1.0
Colvin silty clay loam [1]	18	24	28	34	36	46	30	38	1.5	2.0
Colvin soils, saline [1]	13	16	20	24	24	30	—	—	1.0	1.5
Colvin soils, very poorly drained	—	—	—	—	—	—	—	—	—	—
Cresbard, Barnes, and Cavour loams	14	18	20	26	30	36	18	23	1.0	1.2
Cresbard and Cavour loams	12	15	16	22	23	28	—	—	.9	1.1
Divide loam	15	20	21	26	30	36	20	25	1.0	1.2
Eckman loam, level	20	26	30	38	40	50	32	40	1.6	2.1
Eckman loam, gently sloping	18	24	28	34	38	48	30	38	1.5	2.0
Eckman loam, sloping	14	18	24	30	30	36	26	32	1.2	1.5
Edgeley loam, level	18	24	28	34	36	46	30	38	1.5	2.0
Edgeley loam, undulating	16	22	25	30	32	40	28	36	1.3	1.6
Egeland fine sandy loam, sloping	12	18	20	26	26	34	26	34	1.2	1.5
Egeland fine sandy loam, till substratum, level	16	22	24	30	30	38	30	38	1.4	1.8
Egeland fine sandy loam, till substratum, undulating	15	21	23	29	29	37	29	37	1.4	1.8
Egeland loam, till substratum, undulating	16	22	24	30	32	40	30	38	1.4	1.8
Egeland-Embden fine sandy loams, level	14	20	22	28	28	36	28	36	1.3	1.7
Egeland-Embden fine sandy loams, undulating	13	19	21	27	27	35	27	35	1.3	1.7
Embden fine sandy loam	15	21	23	29	29	37	29	37	1.5	2.0
Embden fine sandy loam, silty substratum	16	22	24	30	30	38	30	38	1.4	1.8
Embden-Gardena loams, till substratum	20	26	30	38	40	50	32	42	1.6	2.1
Exline silt loam	—	—	—	—	—	—	—	—	.7	1.0
Exline-Lamoure complex	—	—	—	—	—	—	—	—	—	—
Fargo silty clay	22	28	32	40	42	52	30	40	1.5	2.0
Fargo and Hegne silty clays	20	26	30	38	40	50	28	38	1.5	2.0
Fordville loam, level	11	15	16	20	20	25	16	20	.9	1.1
Fordville loam, gently sloping	10	14	15	19	18	23	15	19	.9	1.1
Fresh water marsh	—	—	—	—	—	—	—	—	—	—
Gardena loam	22	28	32	40	42	52	35	45	1.6	2.1
Gardena loam, gently sloping	18	24	28	36	38	48	32	42	1.5	2.0
Gardena loam, silty substratum	22	28	32	40	42	52	35	45	1.6	2.1
Gardena loam, till substratum	22	28	32	40	42	52	35	45	1.6	2.1
Gardena and Eckman loams, level	22	28	32	40	42	52	35	45	1.6	2.1
Glyndon silt loam	18	26	32	40	40	50	35	45	1.6	2.1
Glyndon silt loam, gently sloping	18	26	32	40	40	50	30	40	1.6	2.1
Glyndon silt loam, saline	14	16	20	24	25	32	—	—	1.0	1.5
Glyndon silt loam, silty substratum	18	26	32	40	40	50	30	40	1.6	2.1
Grano silty clay	—	—	—	—	—	—	—	—	—	—
Gravel pits	—	—	—	—	—	—	—	—	—	—
Great Bend silty clay loam, gently sloping	18	24	28	34	38	48	30	38	1.5	2.0
Great Bend-Barnes complex, level	20	26	30	38	40	50	30	38	1.6	2.1
Great Bend-Barnes complex, undulating	18	24	27	34	38	48	28	36	1.5	2.0
Hamar fine sandy loam	12	16	20	25	24	30	26	32	1.2	1.6
Hamar loamy fine sand	10	14	16	20	20	26	22	26	1.0	1.4
Hamerly loam	18	24	30	36	37	47	30	38	1.5	2.0

See footnote at end of table.

TABLE 5.—*Estimated average yields per acre of principal crops under two levels of management*—Continued

Soil	Wheat		Barley		Oats		Corn		Tame hay	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Hamerly-Svea loams	19	25	32	38	38	48	32	40	1. 5	2. 0
Hecla fine sandy loam	13	18	21	27	27	35	27	35	1. 2	1. 6
Hecla fine sandy loam, silty substratum	14	20	22	28	28	36	28	36	1. 3	1. 7
Hecla loamy fine sand	10	14	16	20	22	28	22	26	1. 0	1. 4
Hecla loamy fine sand, gently undulating	10	14	16	20	22	28	22	26	1. 0	1. 4
Hecla loamy fine sand, silty substratum	11	15	18	22	24	30	24	28	1. 1	1. 5
Hecla-Hamar complex	12	17	20	26	26	34	26	34	1. 2	1. 6
Hecla-Hamar loamy fine sands, level	10	14	16	20	22	28	22	26	1. 0	1. 4
Hecla-Hamar loamy fine sands, gently undulating	9	14	15	20	20	28	21	26	. 9	1. 4
Hecla-Ulen complex, level	11	15	18	22	23	29	23	28	1. 2	1. 6
Hecla-Ulen complex, gently undulating	10	15	15	22	21	29	21	28	1. 2	1. 6
Hecla-Ulen fine sandy loams	13	18	21	27	27	35	27	35	1. 3	1. 7
Hegne-Fargo complex, sandy substrata	20	26	30	38	40	50	28	38	1. 5	2. 0
LaDelle silt loam	22	28	32	40	42	52	35	45	1. 7	2. 2
LaDelle silty clay loam	22	28	32	40	42	52	35	45	1. 7	2. 2
LaDelle soils, clayey substratum	22	28	32	40	42	52	35	45	1. 7	2. 2
Lamoure silty clay loam [1]	18	24	28	34	36	46	30	38	1. 5	2. 0
Lamoure silty clay loam, saline [1]	13	16	20	24	24	30	------	------	1. 0	1. 5
LaPrairie silt loam	22	28	32	40	42	32	35	45	1. 7	2. 2
LaPrairie silt loam, channeled	20	26	30	38	40	50	32	42	1. 6	2. 1
LaPrairie and Lamoure soils, channeled	------	------	------	------	------	------	------	------	------	------
Letcher fine sandy loam	7	9	12	15	20	25	------	------	. 8	1. 0
Loamy lake beaches	------	------	------	------	------	------	------	------	------	------
Ludden silty clay	20	26	30	38	40	50	28	38	1. 5	2. 0
Ludden silty clay, saline	13	16	20	24	24	28	------	------	1. 0	1. 2
Ludden-Ryan silty clays	16	20	24	30	32	40	------	------	1. 3	1. 7
Maddock fine sandy loam, level	13	18	21	27	27	35	27	35	1. 0	1. 4
Maddock fine sandy loam, undulating	12	17	20	26	26	34	26	34	1. 0	1. 4
Maddock and Barnes soils, rolling	10	12	14	18	20	26	------	------	1. 0	1. 4
Maddock and Hecla fine sands, undulating	------	------	------	------	------	------	------	------	------	------
Maddock and Hecla loamy fine sands, undulating	9	13	15	19	20	26	18	22	1. 0	1. 4
Maddock and Hecla soils, severely eroded	------	------	------	------	------	------	------	------	------	------
Maddock-Hecla loamy fine sands, gently undulating	9	13	15	19	20	26	18	22	1. 0	1. 4
Nutley silty clay, level	22	28	32	40	42	52	30	40	1. 5	2. 0
Nutley silty clay, gently sloping	20	26	30	38	38	48	30	40	1. 4	1. 8
Nutley and Fargo silty clays	22	28	32	40	42	52	30	40	1. 5	2. 0
Overly silt loam	22	28	32	40	42	52	35	45	1. 6	2. 1
Overly-Aberdeen complex	17	22	26	32	36	46	28	36	1. 4	1. 8
Parnell silty clay loam [1]	20	26	30	38	40	50	30	40	1. 5	2. 0
Peat and muck, shallow	------	------	------	------	------	------	------	------	------	------
Perella loam [1]	20	26	30	38	40	50	30	40	1. 5	2. 0
Rauville soils	------	------	------	------	------	------	------	------	------	------
Rauville soils, sloping	------	------	------	------	------	------	------	------	------	------
Renshaw loam, level	11	15	16	20	20	25	16	20	. 9	1. 1
Renshaw loam, gently sloping	10	14	15	19	18	23	15	19	. 9	1. 1
Renshaw and Sioux soils, level	------	------	------	------	------	------	------	------	------	------
Renshaw and Sioux soils, gently sloping	------	------	------	------	------	------	------	------	------	------
Ryan silty clay	------	------	------	------	------	------	------	------	------	------
Ryan-Ludden silty clays	------	------	------	------	------	------	------	------	------	------
Saline land	------	------	------	------	------	------	------	------	------	------
Sioux soils	------	------	------	------	------	------	------	------	------	------
Spottswood loam	15	20	21	26	30	36	20	25	1. 0	1. 2
Stirum fine sandy loam	7	10	12	15	20	25	------	------	. 8	1. 0
Stirum fine sandy loam, very poorly drained	------	------	------	------	------	------	------	------	------	------
Stirum-Exline complex	------	------	------	------	------	------	------	------	. 7	. 9
Stirum-Letcher fine sandy loams	7	9	12	15	20	24	------	------	. 8	1. 0
Svea loam	22	28	32	40	42	52	32	42	1. 7	2. 2
Svea-Barnes loams	21	27	31	39	40	50	30	40	1. 6	2. 1
Tiffany fine sandy loam [1]	16	22	24	32	32	42	30	40	1. 5	2. 0
Tiffany fine sandy loam, silty substratum [1]	17	23	25	33	33	43	31	41	1. 5	2. 0
Tiffany loam [1]	18	24	26	34	34	44	32	42	1. 5	2. 0
Tonka soils [1]	20	26	30	38	40	50	30	40	1. 5	2. 0
Tonka and Parnell soils [1]	20	26	30	38	40	50	30	40	1. 5	2. 0
Ulen fine sandy loam	13	18	21	27	27	35	27	35	1. 3	1. 7
Ulen fine sandy loam, silty substratum	14	20	22	28	28	36	28	36	. 4	1. 8
Ulen-Hamar complex	12	16	20	26	26	34	26	34	1. 2	1. 6
Vallers silty clay loam [1]	18	24	28	34	36	46	30	38	1. 5	2. 0
Venlo fine sandy loam [1]	------	------	------	------	------	------	------	------	------	------

[1] Yields given are for drained areas of these soils.

Range [4]

All of this Survey Area was originally a mixed prairie, except for scattered areas of woodland in the James River Valley. The native vegetation was mainly short, tall, and mid grasses. There were lesser amounts of legumes and other broad-leaved plants. At present, only about 12 percent of the Survey Area is in native plant cover. This acreage consists mainly of soils that are not suitable for cultivation, because of steep slopes, salinity, stoniness, or poor drainage.

Native rangeland occurs in an unbroken pattern only on the steep breaks along the James River Valley (fig. 10) and on some of the more rugged terrain in the northwestern part of La Moure County. Elsewhere, areas of native range occur mainly as scattered tracts on steep hillsides, on stony knolls, along stream channels, and in the many intermittently wet potholes and small lake basins.

Many of the larger tracts of native range have been fenced, and livestock watering facilities have been installed for cattle and sheep. Other scattered areas are included with crop fields and are grazed late in fall or are cut for hay. Livestock enterprises provide a major part of the income of many farmers.

Range sites and condition classes

Soils differ in their capacity to produce different kinds and amounts of range plants, and the composition of the native plant cover varies greatly from place to place. For proper range management, a rancher needs to know the kind and quality of range plants that different kinds of rangeland will produce, and he needs to be able to judge the current condition of the range as compared to its potential capacity.

[4] BY CLAYTON QUINNILD, range conservationist, Soil Conservation Service.

For the purpose of classifying range resources, soils are placed in groups called range sites. Each site has a distinctive potential plant community, or climax vegetation, the composition of which depends upon a combination of environmental conditions, mainly the combined effect of soil and climate. The climax vegetation is the combination of range plants that originally grew on a given range site. It will maintain and reproduce itself so long as the environment remains unchanged.

The plants on each site are grouped as decreasers, increasers, and invaders. Decreasers are species in the climax vegetation that are first to be depleted under continued heavy grazing. They are generally the most palatable and nutritious plants on the site. Increasers are the plants that increase in relative abundance as the more desirable plants are depleted by close grazing. They are commonly shorter, less productive, and less palatable than decreasers. Invaders are plants that come in after the climax vegetation has deteriorated. They consist mainly of annual weeds and other undesirable plants that have little forage value.

Range condition refers to the present condition of the vegetation as compared to what the site is capable of producing. Four classes of range condition are defined. The site is in excellent condition if 75 to 100 percent of the stand consists of the best kinds of vegetation the site is capable of producing. It is in good condition if 50 to 75 percent of the vegetation is the same as the original plant cover, in fair condition if the percentage is between 25 and 50, and in poor condition if the percentage is less than 25.

Descriptions of range sites

The range sites of this Survey Area are described in the following pages. The description of each site gives significant soil characteristics, lists the principal range plants, and gives estimates, in pounds per acre, of annual

Figure 10.—**An area of Buse-Barnes soils on steep side slopes in the James River Valley. This area is used for native range.**

production of herbage. About half of the estimated herbage production is usable forage.

The soil series represented are named in the description of each site, but this does not mean that all the soils of a given series are in the site. To learn the range site for any given soil, refer to the "Guide to Mapping Units." Fresh water marsh and Gravel pits are unsuitable for use as range and are not included in any range site.

WETLANDS RANGE SITE

This range site consists of very poorly drained soils of the Arveson, Borup, Colvin, Grano, Parnell, Perella, Rauville, Stirum, and Venlo series, and of Peat and muck, shallow. These soils are in depressions, channels, and seepage areas. They are occasionally ponded, and the water table rises to the surface during part of the growing season. They are too wet for cultivated crops, but they can be used for grasses and sedges.

The climax vegetation consists mainly of rivergrass, slough sedge, American mannagrass, northern reedgrass, reed canarygrass, and prairie cordgrass. Cattle show a strong preference for rivergrass and slough sedge. If the condition of this site deteriorates, American sloughgrass, slim sedge, common spikesedge, Baltic rush, fowl bluegrass, and foxtail barley increase.

If this site is in excellent condition, the annual yield of herbage ranges from 5,500 to 6,500 pounds.

SUBIRRIGATED RANGE SITE

This range site consists of deep, somewhat poorly drained or poorly drained soils of the Arveson, Borup, Colvin, Hamar, Lamoure, Tiffany, and Vallers series, and of Loamy lake beaches. These soils are in depressions or on low-lying flats. The water table is at a depth of less than 5 feet, and it seldom rises to the surface during the growing season.

This site is not susceptible to erosion, but lowering of the water table reduces its productivity.

The climax vegetation consists mainly of big bluestem, switchgrass, little bluestem, prairie cordgrass, indiangrass, bearded wheatgrass, Canada wildrye, fescue sedge, and Macoun wildrye. If the condition of this site deteriorates, mat muhly, common spikesedge, milkweed, Nuttall cinquefoil, foxtail barley, and fowl bluegrass increase.

If this site is in excellent condition, the annual yield of herbage ranges from 3,800 to 5,000 pounds.

SALINE SUBIRRIGATED RANGE SITE

This range site consists of somewhat poorly drained or poorly drained soils of the Aberdeen, Bearden, Cavour, Colvin, Exline, Glyndon, Lamoure, Letcher, Ludden, Ryan, and Stirum series, and of Saline land. These soils are on bottom lands, lake plains, and outwash plains. They contain a moderate to high concentration of soluble salts, and some salts are visible on the surface when the soils are dry. The water table is just below the subsoil, and it keeps the soils moist most of the time.

The climax vegetation consists mainly of Nuttall alkaligrass, western wheatgrass, slender wheatgrass, and plains bluegrass. The dominant increasers and invaders are inland saltgrass, poverty sumpweed, silverweed cinquefoil, alkali plantain, and shore podgrass.

If this site is in excellent condition, the annual yield of herbage ranges from 2,200 to 3,200 pounds.

OVERFLOW RANGE SITE

This range site consists of poorly drained soils of the Tonka and Parnell series. These soils have a surface layer of loam to silty clay loam. They occur in shallow depressions and receive runoff from higher lying soils. They are occasionally ponded, but the water remains on the surface only a short time. The additional moisture increases the production of herbage.

Decreaser plants in the climax vegetation include big bluestem, green needlegrass, bearded wheatgrass, prairie cordgrass, Canada wildrye, switchgrass, and prairie dropseed. The dominant increasers and invaders are western wheatgrass, side-oats grama, prairie sandreed, mat muhly, needleleaf sedge, and Kentucky bluegrass.

If this site is in excellent condition, the annual yield of herbage ranges from 3,000 to 4,000 pounds.

SANDS RANGE SITE

This range site consists of deep, nearly level to undulating soils of the Hecla and Maddock series. These soils have a surface layer of loose fine sand. They have low moisture-holding capacity and are highly susceptible to erosion.

The climax vegetation consists mainly of prairie sandreed, Canada wildrye, sand bluestem, prairie spiderwort, and leadplant amorpha. The dominant increasers and invaders are needle-and-thread, sand dropseed, sun sedge, rosette panicum, field sagewort, and golden aster.

Most areas of this range site are in poor or fair condition, but some are in good or excellent condition. If this site is in excellent condition, the annual yield of herbage ranges from 2,500 to 3,200 pounds.

SANDY RANGE SITE

This range site consists of well drained and moderately well drained, sandy soils of the Arvilla, Barnes, Claire, Egeland, Embden, Hamar, Hecla, Letcher, Maddock, and Ulen series. These soils are nearly level to rolling. They have a surface layer of loamy fine sand, sandy loam, or fine sandy loam. Some areas have been reworked by wind, and there are many scattered low hummocks. These soils take in water readily, but they have low moisture-holding capacity and are highly susceptible to erosion.

Decreaser plants in the climax vegetation include prairie sandreed, Canada wildrye, and big bluestem. The dominant increasers and invaders are needle-and-thread, sun sedge, threadleaf sedge, blue grama, cudweed sagewort, heath aster, western yarrow, and silverleaf scurfpea.

If this site is in excellent condition, the annual yield of herbage ranges from 2,200 to 2,800 pounds.

SILTY RANGE SITE

This range site consists of moderately well drained and well drained soils of the Aberdeen, Barnes, Bearden, Buse, Cavour, Cresbard, Divide, Eckman, Edgeley, Egeland, Embden, Fordville, Gardena, Glyndon, Hamerly, LaDelle, Lamoure, LaPrairie, Overly, Renshaw, Spottswood, and Svea series. These soils are on glacial till plains, lake plains, terraces, and bottom lands. They have a surface layer of loam or silt loam. Most of them are readily permeable to water, and they have moderately high to high moisture-holding capacity.

The dominant grasses in the climax vegetation are green needlegrass and bearded wheatgrass. Other important de-

creasers are big bluestem, prairie dropseed, little bluestem, American vetch, and prairie groundsel. If the condition of this site deteriorates, western wheatgrass and needle-and-thread increase. Continued overuse of the range causes an increase of shorter grasses and sedges, such as blue grama, sun sedge, threadleaf sedge, and side-oats grama. Cudweed sagewort, western yarrow, and heath aster are common invaders.

If this site is in excellent condition, the annual yield of herbage ranges from 2,000 to 2,500 pounds.

CLAYEY RANGE SITE

This range site consists of deep, moderately well drained to somewhat poorly drained soils of the Barnes, Fargo, Great Bend, Hegne, LaDelle, Ludden, and Nutley series. These soils are on glacial lake plains and in stream valleys. They have a surface layer of granular silty clay loam, silty clay, or clay. Permeability is moderately slow to slow, and the moisture-holding capacity is high.

The dominant plants in the climax vegetation are green needlegrass and western wheatgrass. Early signs of deteriorating range condition are a decrease in green needlegrass and an increase in western wheatgrass. Continued overuse causes a decrease in western wheatgrass and an increase in blue grama and needleleaf sedge. Western yarrow is a common invader.

If this site is in excellent condition, the annual yield of herbage ranges from 1,800 to 2,500 pounds.

THIN SILTY RANGE SITE

This range site consists of medium-textured soils of the Buse and Barnes series. These soils are on steep morainic hills and on valley side slopes. These soils have a thin surface layer, but they have a deep root zone. Although the moisture-holding capacity is high, runoff is rapid and the soils are highly susceptible to water erosion if not protected.

The dominant range plant in the climax vegetation is little bluestem. Other important decreasers are side-oats grama, porcupinegrass, plains muhly, and prairie dropseed. If the condition of this site deteriorates, needle-and-thread, needleleaf sedge, and sun sedge increase.

If this site is in excellent condition, the annual yield of herbage ranges from 1,700 to 2,200 pounds.

SHALLOW TO GRAVEL RANGE SITE

This range site consists of shallow, nearly level to steep soils of the Renshaw and Sioux series. These soils are on terraces and uplands. They are underlain by coarse sand and gravel at a depth of 15 inches or less, and they are droughty.

The dominant grasses in the climax vegetation are needle-and-thread and western wheatgrass. The principal increasers and invaders are blue grama, fringed sagewort, prairie coneflower, and needleleaf sedge.

If this site is in excellent condition, the annual yield of herbage ranges from 1,100 to 2,000 pounds.

Windbreaks [5]

Most of the trees in this Survey Area have been planted to protect farmsteads and fields from wind. The only native woodland is on bottom lands along the James River and in scattered areas in some of the ravines leading into the James River Valley.

The soils of the Area have been grouped in eight windbreak sites. The soils of each site have similar characteristics for growing trees. Windbreak site 1 is made up of the soils best suited to trees, and windbreak site 8, the poorest.

Table 6 gives for each of the windbreak sites a brief general description of the soils, ratings of suitability of the soils for specified kinds of trees, and estimates of height of 20-year-old trees. The data in this table are based on measurements and observations of 20-year-old trees in sites that have had adequate care. The heights given are an average of the upper story in each row. The site number for each soil is shown in the "Guide to Mapping Units."

A suitability rating of good means that the specified trees grow well to moderately well, and that there is little dead wood in the crowns, except where the trees are shaded. Less than 10 percent of the trees have died, have been uprooted, or are stunted. A rating of fair means that there is a moderate amount of dead wood in the upper crowns. Ten to 25 percent of the trees have died, have been uprooted, or are stunted. A rating of poor means that the soils are poorly suited to trees and that in any given area many of the side branches are dead. More than 25 percent of the trees have died, have been uprooted, or are stunted.

Native woodland, planted windbreaks, and preparation and maintenance of windbreak sites are discussed in the following paragraphs.

NATIVE WOODLAND.—The native woodland is mostly in areas north of La Moure. The soils south of La Moure are generally tight, slowly permeable, saline-alkaline clays that are not suitable for native trees. The principal trees are American elm, boxelder, green ash, bur oak, and cottonwood. Chokecherry, wild plum, and juneberry are the most common shrubs. The native woodlands are used principally for wildlife habitat, recreation, and watershed protection. They have little commercial value.

PLANTED WINDBREAKS.—Farmstead windbreaks (fig. 11) are needed to protect farm buildings and livestock from cold, wintry winds and the hot, dry winds of summer. Windbreaks also provide protection for wildlife and for orchards and gardens. Field windbreaks are needed to control wind erosion, especially on the soils of windbreak sites 4 and 5 and on some of the soils of windbreak site 1. Most windbreaks consist of narrow plantings at intervals of 20 to 40 rods, depending on the erodibility of the soil. Such windbreaks are effective in reducing wind velocity for a distance of 10 times the height of the tree, and in places, for a distance of 20 times the height. Shrubs and short trees make effective snow fences. In this Area most windbreaks are single-row plantings (fig. 12), but some consist of as many as three rows and are most effective when used with other conservation practices.

PREPARATION AND MAINTENANCE OF WINDBREAK SITES.—The method of preparation of the planting site depends largely on the kind of soil. If the soil is moderately coarse textured to fine textured, the site should be in summer fallow or row crops the year before planting. In sandy, erodible areas the trees should be planted in clean stubble.

[5] By ELMER L. WORTHINGTON, woodland conservationist, Soil Conservation Service.

TABLE 6.—*Windbreak sites and estimated height of suitable trees and shrubs*

[Dashed lines indicate that the site is poorly suited to the specified kind of tree or shrub]

Windbreak site	Height at 20 years of age									
	Green ash	American elm	Siberian elm	Cottonwood	Cedar	Pine	Spruce	Russian-olive	Honeysuckle	Caragana
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
1. Deep, nearly level soils that are loamy fine sand to silty clay in texture. Little or no water is lost by runoff, and the water table is within the reach of roots. The surface soil is neutral or calcareous. Included are small areas of gently sloping, moderately well drained soils. Productivity of all suitable species is good. (Bo, Dd, Em, En, Eo, Fc, Fh, Ga, GaB, Gb, Gc, Gl, GlB, Gn, Hf, Hg, Hh, Hk, Hl, HlB, Hm, HuA, HuB, Hv, Hx, La, Lc, Ld, Lg, Ll, Lu, Oe, Sp, Sv, Ue, Uf; Svea part of BnB and Sw; Embden part of EgA and EgB; Gardena part of GeA; Hecla part of Hn, HoA, HoB, HuA, McB, MhB, Mk3, and MmB; LaPrarie part of Lm; Fargo part of Ny; Ulen part of Uh)	20–26	20–26	26–32	42–50	9–12	15–18	14–17	16–20	8–11	9–12
2. Deep, undulating to nearly level, well-drained, loamy soils. Some water is lost by runoff, and the water table is beyond the reach of roots. Cottonwood and spruce are poorly suited. Productivity of all other species is good. (Bc, BgA, EaA, EaB, EbA, EbB, EdA, EdB, EeB, GrB, GtA, GtB; Barnes part of BnB, Sw; Egeland part of EgA, EgB; Eckman part of GeA)	17–22	17–22	21–27	-------	11–15	16–20	-------	14–18	7–9	8–10
3. Deep, nearly level to undulating, moderately well-drained, clayey soils. The water table is beyond the reach of roots. The surface soil is neutral or slightly calcareous. Productivity of cedar is good; it is poor for cottonwood and spruce and fair for other species. (NuA, NuB, Nutley part of Ny)	14–18	14–18	20–24	-------	10–14	12–16	-------	9–13	5–7	6–8
4. Deep, undulating to nearly level, well-drained, sandy soils. The water table is generally beyond reach of roots. The surface soil is neutral. Productivity of green ash, American elm, and Caragana is good; it is poor for cottonwood and spruce and fair for other species. (MaA, MaB, Maddock part of MbC, McB, MhB, Mk3, MmB)	15–19	15–19	12–22	-------	9–11	14–17	-------	10–14	5–7	7–9
5. Moderately deep, loamy and sandy soils overlying coarse sand and gravel. The water table is beyond the reach of roots in most places. The surface soil is neutral. Cottonwood and spruce are poorly suited; productivity of all other species is fair (ArA, ArB, Ce, FvA, FvB, ReA, ReB)	10–14	10–14	15–18	-------	8–10	13–16	-------	8–10	4–5	5–7
6. Deep, rolling and hilly, loamy soils that are droughty because of runoff. The water table is beyond the reach of roots. Cottonwood and spruce are poorly suited; productivity of all other species is fair. (BaC, BaC2, BbC, BbD, BhC, EaC, EcC, Barnes part of MbC)	12–16	12–16	16–20	-------	9–11	14–17	-------	9–12	5–7	6–8
7. Poorly drained, loamy and clayey soils. These soils receive runoff, and undrained areas are occasionally to frequently ponded. In most places, however, the soils have been drained; they are not subject to seepage. Productivity of all suitable species is good. (Af, An, Go, Ha, He, Pa, Pr, Tf, Tg, Tn, To, Tp, Ve; Hamar part of Hn, HoA, HoB, Uh; Ulen part of HuA)	20–26	20–26	26–32	42–50	9–12	15–18	14–17	16–20	8–11	9–12

TABLE 6.—*Windbreak sites and estimated height of suitable trees and shrubs*—Continued

Windbreak site	Height at 20 years of age									
	Green ash	American elm	Siberian elm	Cottonwood	Cedar	Pine	Spruce	Russian-olive	Honeysuckle	Caragana
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
8. Soils that are shallow, droughty, slowly permeable, wet, or too saline or too alkaline for satisfactory growth of trees. Included in this group are soils that are too stony for cultivation. Productivity of all species is poor. (Ab, Ae, Be, Br, Bs, Bt, Bu, BvE, Ca, Ch, Co, Cs, Cu, Cv, Es, Ex, Gm, Le, Lf, Ln, Lo, Lw, Ly, Or, Pm, Ra, RaC, RsA, RsB, Ru, Ry, Sa, So, Sr, Ss, St, Su, Va; Lamoure part of Lm)	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

The site should be free of grass and perennial weeds before the trees are planted. The young trees should be machine cultivated until they are too big for machinery to pass between them. Herbicides can be used to control weeds. All plantings need protection from fire and grazing. Control of insects, rodents, and disease may be needed.

Wildlife [6]

The capability of the land to support wildlife depends on the kind of soil and the land use. Suitable habitat is more important to the survival of wildlife species than favorable weather or lack of predators. Land use determines the amount, quality, and distribution of wildlife food and cover. Changes in land use are generally reflected in changes in kinds and numbers of wildlife in the area. For example, conversion of grassland to farms has eliminated the once-common bison and antelope and greatly reduced the numbers of sharp-tailed grouse, but has created a habitat suitable for pheasant and partridge. Since the distribution of wildlife is closely related to use and management of the soils, it is discussed in relation to the soil associations, which are described in the section "General Soil Map."

[6] By ERLING B. PODOLL, biologist, Soil Conservation Service.

***Figure 11.*—Farmstead windbreak on Svea-Barnes loams. These are mature trees that form an effective barrier against wind.**

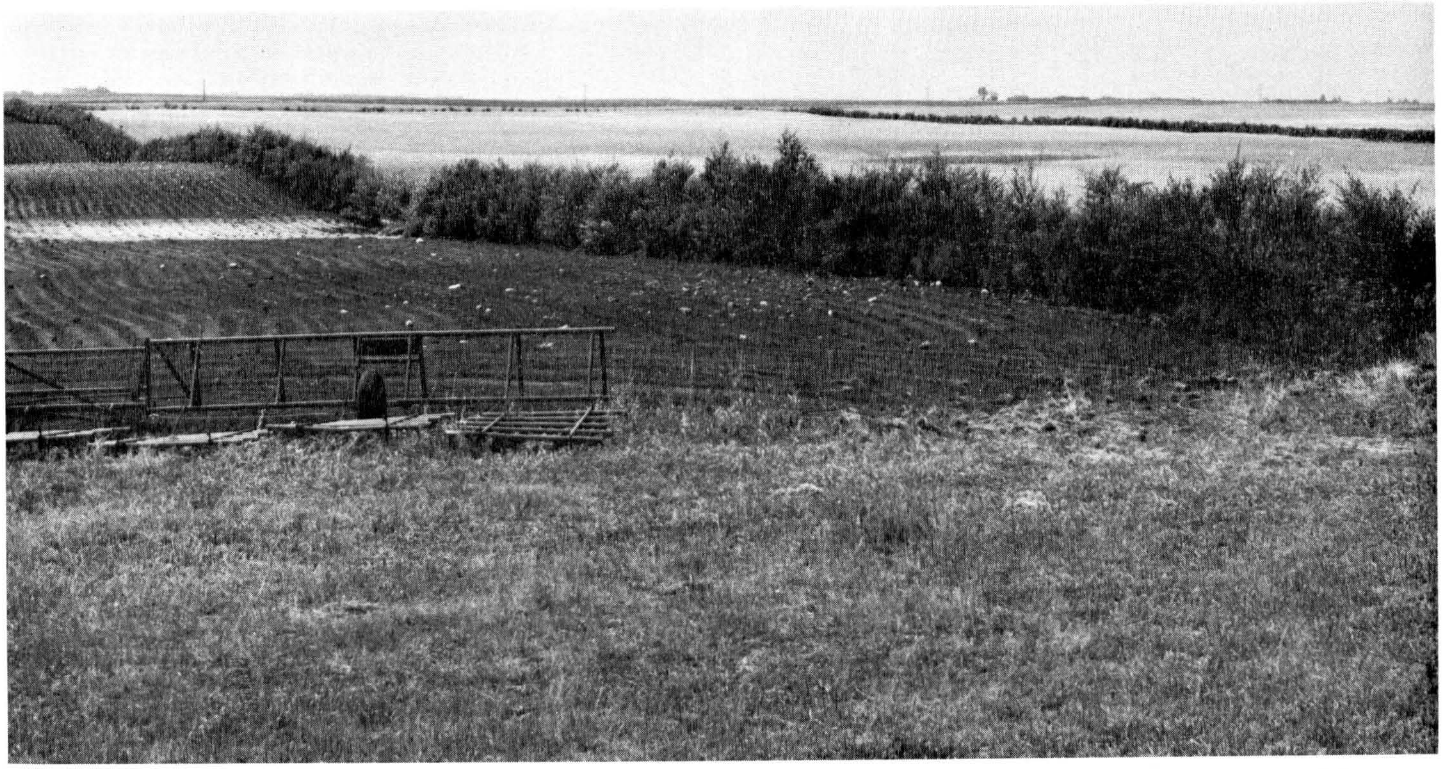

***Figure 12.*—Single-row field windbreak on Barnes-Svea loams, undulating. The light-colored area in left center is a Tonka silt loam.**

Important species of wildlife in the Survey Area are pheasant, partridge, mink, muskrat, beaver, jackrabbit, duck, geese, and deer. Those of lesser importance are sharp-tailed grouse and prairie chicken.

Pheasant.—This Area has a high potential for the ring-necked pheasant, which has been successfully introduced. Pheasants are associated with cropland because they depend on farm crops and associated weed seeds for food. The best habitat is in the Barnes-Svea, LaPrairie-Eckman-Renshaw-Fordville, Embden-Gardena, Hecla-Maddock, Hecla-Ulen, and Gardena-Glyndon-Overly associations. Areas that provide a fair habitat are in the Barnes-Svea-Parnell, Buse-Eckman-Renshaw-LaPrairie, Barnes-Cresbard, and Edgeley associations. The potential for pheasant habitat in the LaDelle-Lamoure-Ludden-Ryan association ranges from poor to good. The more clayey soils of this association, such as Ludden silty clay, are less suitable for pheasant habitat.

Pheasants need adequate cover for nesting and roosting. Nesting cover can be provided by grassy, weedy areas that are not likely to be disturbed during the nesting season, May through June. Roosting cover can be provided by the kind of herbaceous vegetation that is native to wetlands. Winter cover is lacking in many places; it can be provided by planting tracts of herbaceous vegetation and shrubs or combinations of shrubs and trees arranged to control the drifting of snow.

Gray (Hungarian) partridge.—These small game birds have been introduced in this Area. Their habitat needs are similar to those of pheasants, but they prefer somewhat more open sites and they need less winter cover and protection of roosting areas. The best habitat for partridge consists of a large number of well-distributed shrub thickets.

Sharp-tailed grouse.—This native game bird needs grassland, shrub thickets, and scattered tracts of woodland. Its potential is low because of the small amount of grassland. Habitat suitable for grouse is generally limited to the Buse-Barnes and Barnes-Svea-Parnell associations. The habitat for these birds can be maintained or improved by controlled grazing, providing well-distributed shrub thickets on their breeding range, and planting or protecting large tracts of shrubs or combinations of shrubs and trees that can be used for winter cover.

Prairie chicken.—This game bird needs tall grasses, such as big bluestem and little bluestem. Its population is small because grasslands are generally grazed heavily by livestock or are used for hay. Protecting small, well-distributed areas of tall grasses from overgrazing is the best way to improve the habitat. Several associations have a potential for prairie chicken. These are the Buse-Barnes, Barnes-Svea-Parnell, Barnes-Cresbard, and LaDelle-Lamoure-Ludden-Ryan associations.

Furbearers.—Among the furbearing animals in the Area, the most important are minks, muskrats, beavers, and jackrabbits. Skunks, foxes, badgers, weasels, and raccoons are less important because the demand for their fur is limited.

Jackrabbits find habitat throughout the Survey Area. In most years they are the source of most of the income from furbearers. Minks, muskrats, and beavers are associated with streams and wetlands. The beaver range is mainly along the James River. The best potential for mink and muskrats is in the wetlands associated with the

Barnes-Svea-Parnell, Buse-Barnes, LaPrairie-Eckman-Renshaw-Fordville, and LaDelle-Lamoure-Ludden-Ryan associations. The potential is fair in the Barnes-Svea association. The habitat for mink and muskrats can be improved by constructing level ditches, impoundments, and facilities for controlling the water level. It can also be improved by protecting the vegetation on the margins of sloughs, on streambanks, and along the edges of facilities used for watering livestock.

DUCKS.—Ducks are numerous, especially in the western part of La Moure County. Most are mallards, pintails, and blue-winged teal. Other species include gadwalls, redheads, canvasbacks, ruddy ducks, American widgeons, and shovelers. The most favorable areas are in the Buse-Barnes, Barnes-Svea-Parnell, and Barnes-Svea associations. Parnell and Grano soils, the most suitable of the wetland soils, can be developed as habitat for ducks by constructing ponds and by protecting the margins of wetlands from trampling by livestock.

GEESE.—Migrating geese find resting places on the large natural bodies of water in the Barnes-Svea association. They do not use the Area as permanent habitat. More geese could be attracted by impounding shallow water.

WHITE-TAILED DEER.—These deer are found in all parts of the survey Area, but they are most numerous where there is woody cover or tall wetland vegetation. The highest potential for deer habitat is in the LaPrairie-Eckman-Renshaw-Fordville, Buse-Barnes, Barnes-Svea-Parnell, Buse-Eckman-Renshaw-LaPrairie, and Barnes-Svea associations. Protecting woods, wooded draws, wetlands, and the margins of shrubby wetlands from damage by livestock are essential if the habitat is to be maintained.

SMALL BIRDS AND MAMMALS.—Among the small birds and mammals found in the survey Area are mourning doves, seed-eating and insect-eating songbirds, cottontail rabbits, and tree squirrels. The most common insect-eating songbirds are meadowlarks, tree sparrows, kingbirds, nighthawks, swallows, lark buntings, robins, and woodpeckers.

FISH.—The only fishing waters in the Survey Area are manmade. The most important are at a point on the James River where a dam has been constructed near La Moure.

Perch, bullheads, and northern pike are the most common kinds of fish. There are few private fishponds. The Barnes-Svea-Parnell and the Buse-Eckman-Renshaw-LaPrairie associations have good potential for construction of farm ponds suitable for bass and bluegills.

Engineering Uses of the Soils[7]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. Among the properties most important to the engineer are permeability to water, shear strength, consolidation characteristics, texture, plasticity, and soil reaction. Also important are topography and depth to the water table. All the soils except those of the Edgeley series are deep over bedrock. The depth to bedrock is 2 to 5 feet in the Edgeley soils.

The information in this section can be used to—

1. Make estimates of runoff and erosion characteristics for planning and design of structures.
2. Correlate performance of structures with types of soil and develop information that will be useful in design and maintenance of such structures.
3. Estimate terrain conditions, such as topography, surface drainage, subsurface drainage, and depth to the water table.
4. Make soil and land-use studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
5. Make reconnaissance surveys of soil and ground conditions that will aid in the selection of routes or locations for large drains, irrigation canals, highways, and airports, and in planning detailed investigations at the intended locations.
6. Aid in engineering classification of the soils.
7. Locate probable sources of sand, gravel, rock, and other construction materials.
8. Supplement information obtained from published maps and reports and from aerial photographs for the purpose of making soil maps and reports that can be used readily by engineers.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or excavations deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Much of the information in this section is presented in the form of tables. Only the data in table 7 are from actual laboratory tests. The estimates in table 8 and the interpretations in table 9 are based on comparisons of soils with those tested. At many construction sites, major variations in soil characteristics occur within the depth of the proposed excavation, and several kinds of soil may occur within short distances. Specific laboratory data on engineering properties of the soil at the site should be obtained before planning detailed engineering work.

Some of the terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms as they are used in soil science.

Engineering classification systems

Two systems of classifying soils for engineering purposes are in general use. Classification of the soils of this Survey Area according to both of these systems is given in this survey. The system used by the American Association of State Highway Officials (AASHO) (*1*) is based on field performance of soils in highways. In this system soil materials are classified into seven principal groups, designated A-1 through A-7. The best materials for use in highway subgrades (gravelly soils of high bearing capacity) are classified A-1, and the poorest (clayey soils having low strength when wet) are classified A-7. The relative engineering value of the soils within each group

[7] By R. R. BOONE, area engineer, Soil Conservation Service.

is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest.

The Unified system of soil classification was developed by the Waterways Experiment Station, Corps of Engineers (*17*). This system is based on identification of soils according to texture and plasticity and on performance as engineering construction material. In this system, soils are identified as coarse grained (eight classes), fine grained (six classes), or highly organic.

Engineering test data

Samples of several soil types were tested at the Soil Mechanics Laboratory, Engineering Experiment Station, North Dakota State University, in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*). These samples do not represent all the soils of the Survey Area, or even the maximum range of characteristics of each series sampled, because not all the layers of each profile were sampled.

Moisture-density data are given in table 7. Compaction tests determine the density to which a soil can be compacted at varying content of moisture and varying compactive force. The highest density obtained is termed maximum dry density, and the corresponding moisture content is termed optimum moisture.

Tests for liquid limit and plastic limit measure the effect of water on the consistence of soil material. As the moisture content of a soil is increased from a dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic state to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material changes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition. If the liquid limit or plastic limit cannot be determined, or if the plastic limit is equal to or higher than the liquid limit, the plasticity index is given as nonplastic.

Estimated properties

Table 8 gives estimates of some of the soil properties that are significant in engineering. The estimates are based on the test data in table 7, on comparison of other soils with those tested, and on experience in the field. These estimates should not be considered a substitute for detailed examination at the specific site of proposed construction.

Permeability indicates the rate at which water moves through soil material in its undisturbed state. The estimates are based mainly on soil texture and structure.

Available water capacity is an estimate of the amount of water in a soil available to plants when the soil moisture is at field capacity.

Dispersion refers to the degree of slaking and the rapidity with which soil structure breaks down.

Shrink-swell potential is an indication of the volume change to be expected when the moisture content of the soil material changes. Soils that have a high shrink-swell potential normally present engineering problems, because the increase in volume when the soil is wet is generally accompanied by a loss in bearing capacity.

Engineering interpretations

Table 9 gives estimates of the suitability of the soils for specified uses and describes some of the characteristics of the soils that affect the design, construction, and maintenance of engineering structures.

The ratings of the soils as a source of topsoil are based on their suitability for use in road cuts and as fill material for the purpose of establishing vegetation.

In rating soils for sewage disposal fields, the limitations are described as slight, moderate, or severe. A rating of slight indicates the soil has no unfavorable features. In soils that have moderate limitations as sewage disposal fields for septic tanks, permeability is 1.0 to 0.63 inches per hour, the water table is occasionally at a depth of less than 4 feet, or the slope is between 5 and 10 percent. In soils that have severe limitations for disposal fields for septic tanks, permeability is less than 0.63 inches per hour, the water table is frequently at a depth of less than 2 feet, the soils are occasionally or frequently flooded, and the slope is more than 10 percent. In soils that have moderate limitations as disposal fields for lagoons, permeability is 0.63 to 2.0 inches per hour, the slope is 2 to 7 percent, or the soils are unstable when used for embankments. In soils that have severe limitations for lagoons, permeability is more than 2.0 inches per hour, the slope is 7 percent or more, or the soils are unstable when used for embankments.

Formation and Classification of the Soils

This section describes the major factors of soil formation as they relate to the soils of this Survey Area and explains the system of classifying soils in broader categories. It also contains a section on data obtained by physical and chemical analyses of selected soils.

Factors of Soil Formation

The factors that determine the characteristics of the soil at any given point are the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief and drainage; and the length of time these forces have been active.

Climate and vegetation are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the development of distinct horizons.

The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor because the effect of each is modified by the other four. Many of the processes of soil development are unknown.

TABLE 7.—*Engi-*

[Tests performed by North Dakota State University in cooperation with North Dakota State Highway Department and of State Highway

Soil name and location	Parent material	North Dakota report No. SCS–	Depth from surface	Moisture-density[1]	
				Maximum dry density	Optimum moisture
			Inches	*Lb. per. cu. ft.*	*Percent*
Barnes loam:					
0.2 mile east and 120 feet south of NW. corner of sec. 31, T. 134 N., R. 63 W. (modal).	Glacial till.	151	6–15	111	14
		152	19–28	111	15
		153	38–60	112	16
130 feet east and 220 feet south of NW¼ corner of sec. 7, T. 133 N., R. 62 W. (coarser textured).	Glacial till.	154	8–20	113	14
		155	20–36	114	15
		156	36–60	118	14
130 feet west and 140 feet north of SE¼ corner of sec. 27, T. 134 N., R. 66 W. (finer textured).	Glacial till.	157	7–18	107	17
		158	18–30	112	15
		159	30–60	107	16
Cavour loam:					
55 feet north and 250 feet west of railroad, sec. 36, T. 133 N., R. 64 W. (saline subsoil).	Glacial till.	205	6–13	105	18
		206	30–48	109	18
0.15 mile north and 210 feet west of SE. corner of sec. 15, T. 136 N., R. 59 W. (modal).	Glacial till.	210	10–18	110	13
		211	18–36	114	15
		212	36–60	114	13
120 feet east and 0.2 mile north of SW. corner of sec. 35, T. 136 N., R. 59 W. (sand substratum).	Glacial till.	207	8–20	108	17
		208	30–42	112	13
		209	42–60	111	14
Edgeley loam:					
75 feet north and 165 feet west of E¼ corner, sec. 27, T. 133 N., R. 64 W. (modal).	Glacial till over shale.	189	9–22	91	25
		190	27–42	72	40
		191	42–60	76	35
50 feet east and 80 feet south of N¼ corner, sec. 35, T. 133 N., R. 64 W. (no B3 horizon).	Glacial till over shale.	195	6-17	78	34
		196	17–27	73	38
		197	27–60	76	37
0.4 mile east of SW. corner of sec. 25, T. 133 N., R. 64 W. (shallow).	Glacial till over shale.	192	6–13	86	27
		193	13–29	82	24
		194	29–60	74	38
Egeland loam, till substratum:					
125 feet north and 425 feet east of W¼ corner, sec. 19, T. 133 N., R. 62 W. (shallow).	Glacial melt-water deposits over glacial till.	168	0–7	106	15
		169	7–19	119	12
		170	24–30	120	12
		171	30–50	114	14
Embden loam:					
100 feet north and 165 feet west of S¼ corner, sec. 19, T. 133 N., R. 62 W. (sandier substrata).	Glacial melt-water deposits.	160	0–16	117	12
		161	16–36	118	11
		162	44–50	116	14
		163	50–60	116	12
Embden loam, till substratum:					
85 feet east and 100 feet north of W¼ corner, sec. 29, T. 133 N., R 62 W. (till substratum at a depth of 3 feet).	Glacial melt-water deposits over glacial till.	164	0–10	111	13
		165	10–18	116	12
		166	18–26	116	14
		167	38–48	112	16

See footnotes at end of table.

neering test data

U.S. Department of Commerce, Bureau of Public Roads, in accordance with standard procedures of the American Association Officials (AASHO)]

Mechanical analysis [2]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—						AASHO [3]	Unified [4]
¾-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
									Percent			
100	99	95	88	59	52	37	23	16	26	8	A–4(5)	CL
100	98	98	92	69	63	52	34	23	35	16	A–6(9)	CL
100	99	97	88	65	59	46	28	20	31	13	A–6(7)	CL
([5])	100	98	93	66	54	33	16	11	25	4	A–4(6)	ML–CL
97	96	94	89	66	60	49	33	18	28	12	A–6(7)	CL
100	98	96	89	63	57	43	27	18	26	10	A–4(6)	CL
100	99	97	89	64	59	49	35	27	36	17	A–6(9)	CL
100	98	96	90	67	62	50	34	18	33	18	A–6(10)	CL
100	99	97	92	70	63	50	35	26	36	18	A–6(10)	CL
100	99	99	94	72	65	50	29	16	32	12	A–6(8)	CL
100	98	93	88	67	61	50	37	25	41	24	A–7–6(12)	CL
---------	100	99	95	72	64	48	32	25	32	15	A–6(9)	CL
---------	100	99	94	74	68	56	37	28	29	15	A–6(10)	CL
[5] 99	93	88	81	64	59	46	29	21	31	15	A–6(8)	CL
100	97	97	86	70	65	55	40	31	40	18	A–6(10)	CL
100	99	97	64	6	6	6	6	2	([6])	([6])	A–3(0)	SP–SM
100	98	94	86	66	59	47	33	27	37	22	A–6(11)	CL
---------	100	98	91	69	58	43	33	23	37	8	A–4(7)	ML
100	92	69	65	60	47	33	27	21	64	17	A–7–5(10)	MH
[5] 93	50	29	23	20	14	7	5	3	47	11	A–2–7(0)	GM
100	99	92	85	67	58	43	21	12	51	9	A–5(8)	MH
[5] 96	71	46	32	23	19	15	9	6	58	15	A–2–7(0)	SM
[5] 93	48	26	18	12	10	8	5	3	([6])	([6])	A–1–a(0)	GM
100	96	89	81	57	45	30	20	13	38	8	A–4(4)	ML
[5] 99	79	57	45	31	25	17	9	6	([6])	([6])	A–2–4(0)	SM
[5] 91	43	24	11	7	5	4	3	2	51	9	A–2–5(0)	GW–GM
100	99	99	93	39	32	21	10	5	([6])	([6])	A–4(1)	SM
---------	100	99	92	32	25	17	13	10	---------	([6])	A–2–4(0)	SM
100	98	97	92	44	37	26	18	15	22	4	A–4(2)	SM–SC
100	99	96	89	63	57	45	32	22	30	15	A–6(8)	CL
---------	--------	100	94	22	17	12	8	6	([6])	([6])	A–2–4(0)	SM
---------	--------	100	94	23	17	12	10	8	([6])	([6])	A–2–4(0)	SM
---------	--------	100	98	58	52	43	33	26	26	12	A–6(5)	CL
---------	--------	100	97	23	18	13	11	9	([6])	([6])	A–2–4(0)	SM
---------	--------	100	95	31	25	18	10	7	([6])	([6])	A–2–4(0)	SM
---------	--------	100	97	31	25	17	13	11	([6])	([6])	A–2–4(0)	SM
---------	--------	100	98	47	42	33	24	18	21	4	A–4(2)	SM–SC
100	99	97	91	65	60	48	34	25	31	15	A–6(8)	CL

TABLE 7.—*Engineering*

Soil name and location	Parent material	North Dakota report No. SCS–	Depth from surface	Moisture-density [1]	
				Maximum dry density	Optimum moisture
			Inches	*Lb. per. cu. ft.*	*Percent*
Gardena loam:					
160 feet south and 75 feet east of W¼ corner, sec. 33, T. 134 N., R. 60 W. (modal).	Glacial melt-water deposits.	175	0–17	94	22
		176	22–36	106	18
		177	36–48	107	16
160 feet north and 160 feet west of SE. corner sec. 20, T. 134 N., R. 62 W. (coarser textured).	Glacial melt-water deposits.	178	8–18	115	14
		179	18–27	114	13
		180	27–48	117	13
40 rods south and 50 feet west of E¼ corner, sec. 3, T. 134 N., R. 60 W. (finer textured).	Glacial outwash material.	172	0–8	104	17
		173	8–18	105	18
		174	30–48	112	15
Renshaw loam:					
40 feet north and 170 feet west of E¼ corner, sec. 16, T. 134 N., R. 64 W. (modal).	Outwash sand and gravel.	198	6–18	115	12
		199	22–60	125	11
50 feet south and 335 feet west of NE. corner of sec. 8, T. 135 N., R. 63 W. (coarse gravel in substratum).	Outwash sand and gravel.	200	6–20	120	10
		201	23–60	128	10
100 feet east and 80 feet south of NW. corner of sec. 26, T. 133 N., R. 61 W. (deeper than modal).	Glacial stream deposits.	202	14–28	118	12
		203	32–41	128	9
		204	42–60	116	11

[1] Based on AASHO Designation T 99–57, Methods A and C (*1*).

[2] Analysis according to AASHO Designation T 88. Results by this procedure frequently differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

test data—Continued

Mechanical analysis [2]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—						AASHO [3]	Unified [4]
¾-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
									Percent			
------	------	100	98	83	70	46	22	11	37	7	A–4(8)	ML
------	------	------	100	96	84	61	43	31	37	17	A–6(11)	CL
------	------	------	100	96	86	64	43	33	38	19	A–6(12)	CL
------	------	100	99	50	41	26	18	13	21	2	A–4(3)	SM
------	------	------	100	53	40	24	18	14	23	3	A–4(4)	ML
------	------	100	99	67	54	34	25	19	24	5	A–4(6)	ML–CL
------	------	100	98	71	62	42	24	16	30	9	A–4(7)	ML–CL
------	------	100	99	80	70	50	35	28	34	15	A–6(10)	CL
------	------	------	100	78	66	46	34	25	30	11	A–6(8)	CL
100	99	95	78	43	39	29	15	11	28	12	A–6(2)	SC
[5] 96	77	59	38	6	6	6	4	3	([6])	([6])	A–1–b(0)	SP–SM
100	99	97	88	43	36	25	18	15	21	2	A–4(2)	SM
[5] 87	57	45	32	8	7	5	4	3	([6])	([6])	A–1–b(0)	SP–SM
100	99	97	85	47	41	28	17	10	22	5	A–4(2)	SM–SC
100	92	77	61	17	14	11	8	5	([6])	([6])	A–2–4(0)	SM
100	99	95	76	21	15	9	7	3	([6])	([6])	A–2–4(0)	SM

[3] Based on AASHO Designation M 145–49.

[4] Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given a borderline classification. An example of a borderline classification so obtained is ML–CL.

[5] 100 percent passed the 1-inch sieve.

[6] Nonplastic.

TABLE 8.—*Estimated*

[Interpretations are not given for Fresh water marsh; Gravel pits; Loamy lake beaches; Peat

Soil series and map symbols	Depth to seasonally high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Aberdeen: Ab, Ae For Exline part of Ae, see Exline series.	2–3	0–10 10–21 21–60	Silt loam Silty clay loam Silty clay loam or silt loam	CL CH CL	A–6 A–7 A–6 or A–7
Arveson: Af, An	0–3	0–10 10–60	Fine sandy loam Loamy fine sand	SM SM	A–2–4 A–2–4
Arvilla: ArA, ArB	(1)	0–14 14–60	Sandy loam Coarse sand and gravel	SM SP–SM	A–2–4 A–1–b
Barnes: BaC, BaC2, BbC, BbD, Bc, Be, BgA, BhC, BnB. For Buse part of BbC and BbD, see Buse series; for Cresbard part of Bc, see Cresbard series; for Gardena and Eckman parts of BgA, see their respective series; for Renshaw part of BhC, see Renshaw series; for Svea part of BnB, see Svea series.	(1)	0–20 20–60	Loam Loam	CL CL	A–4 or A–6 A–4 or A–6
Bearden: Bo, Br, Bs For Exline part of Bs, see Exline series.	2–5	0–13 13–60	Silt loam Silty clay loam	ML–CL CL	A–4 A–6
Borup: Bt, Bu	0–3	0–24 24–60	Silt loam Sandy loam	CL SM	A–4 A–2–4 or A–4
Buse: BvE	(1)	0–5 5–60	Loam Loam	CL CL	A–4 or A–6 A–4 or A–6
Cavour: Ca	(1)	0–6 6–18 18–60	Loam Silty clay loam Loam, silt loam	CL CL CL	A–4 or A–6 A–6 A–7 or A–6
Claire: Ce	(1)	0–9 9–34 34–60	Sandy loam Loamy coarse sand Coarse sand	SM SM SP–SM	A–2–4 A–2–4 A–1–b
Colvin: Ch, Co, Cs	0–3	0–60	Silty clay loam	CL	A–6 or A–7
Cresbard: Cu, Cv For Cavour part of Cu and Cv, see Cavour series.	(1)	0–7 7–24 24–60	Loam Clay loam Clay loam	CL CL CL	A–4 or A–6 A–6 or A–7 A–6
Divide: Dd	2–5	0–22 22–36 36–60	Loam Loamy coarse sand Coarse sand and gravel	ML or CL SM SP–SM	A–4 or A–6 A–2–4 A–1 or A–2
Eckman: EaA, EaB, EaC	(1)	0–14 14–44 44–60	Loam Loam Very fine sandy loam	CL or ML ML or CL SM	A–4 to A–6 A–4 or A–6 A–2–4 or A–4
Edgeley: EbA, EbB	(1)	0–36 36–60	Loam Bedded shale.	CL, ML, or MH	A–4 or A–7
Egeland: EcC, EgA, EgB For Embden part of EgA and EgB, see Embden series.	(1)	0–22 22–60	Fine sandy loam and loam Loamy fine sand and fine sand.	SM SM	A–2–4 A–2
Egeland, till substratum: EdA, EdB, EeB	(1)	0–30 30–60	Fine sandy loam and loam Loam	SM CL	A–2–4 or A–4 A–6
Embden: Em	(1)	0–18 18–38 38–60	Loam or fine sandy loam Fine sandy loam Fine sandy loam or loamy fine sand.	SM SM SM, CL	A–2–4 or A–4 A–2–4 or A–4 A–2–4 or A–4, A–6

See footnotes at end of table.

properties of the soils

and muck, shallow; and Saline land. These land types have a wide range in characteristics]

Percentage passing sieve—			Permea-bility	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
			Inches per hour	*Inches per inch of soil*	*pH*			
---------	100	70–90	0. 63–2. 0	0. 17	6. 1–6. 5	None	Low	Moderate.
---------	100	90–95	0. 01–0. 2	. 19	6. 6–7. 3	None or moderate	High	High.
---------	100	70–90	0. 05–0. 2	. 18	7. 4–7. 9	Moderate or severe	Moderate	Moderate.
---------	100	25–35	2. 0–6. 3	. 12	7. 4–8. 4	None or slight	Low	Low.
---------	100	15–25	6. 3+	. 08	7. 9–8. 4	None	Low	Low.
98–100	95–100	24–35	2. 0–6. 3	. 12	6. 6–7. 3	None	Low	Low.
55–80	45–60	5–10	6. 3+	. 02	7. 9–8. 4	None	Low	Low.
96–100	95–98	55–75	0. 63–2. 0	. 16	6. 6–7. 3	None	Low	Moderate.
96–100	94–98	55–75	0. 2–2. 0	. 17	7. 4–8. 4	None or moderate	Low	Moderate.
---------	100	70–90	0. 63–2. 0	. 16	7. 4–7. 8	None [2]	Low	Moderate.
---------	100	80–95	0. 2–0. 63	. 18	7. 9–8. 4	None or slight	Low	Moderate.
100	95–100	60–80	0. 63–2. 0	. 16	7. 1–8. 4	None	Low	Moderate.
100	90–100	25–40	2. 0–6. 3	. 12	7. 9–8. 4	None or slight	Low	Low.
96–100	95–98	55–75	0. 63–2. 0	. 16	6. 6–7. 3	None	Low	Moderate.
96–100	94–98	55–75	0. 2–2. 0	. 17	7. 4–8. 4	None or moderate	Low	Moderate.
98–100	95–98	55–75	0. 63–2. 0	. 16	6. 6–7. 3	None	Low	Moderate.
100	95–100	70–80	0. 01–0. 20	. 17	7. 4–8. 4	Moderate	High	Moderate.
93–100	90–100	60–75	0. 20–2. 0	. 17	7. 9–8. 4	Severe	Moderate	Moderate.
---------	100	25–35	2. 0–6. 3	. 09	6. 1–6. 5	None	Low	Low.
---------	100	15–25	6. 3+	. 05	6. 6–7. 3	None	Low	Low.
55–80	45–60	5–10	6. 3+	. 02	7. 4–7. 8	None	Low	Low.
100	98–100	80–95	0. 20–0. 63	. 18	7. 4–8. 4	Slight [2]	Low	Moderate.
98–100	95–100	55–75	0. 63–2. 0	. 15	6. 1–6. 5	None	Low	Moderate.
100	95–100	70–80	0. 01–0. 20	. 17	6. 6–7. 3	Slight or moderate	High	Moderate.
97–100	94–98	65–80	0. 2–2. 0	. 17	7. 9–8. 4	Moderate or severe	Moderate	Moderate.
98–100	95–100	50–75	0. 63–2. 0	. 16	7. 1–8. 4	None or slight	Low	Moderate.
---------	100	15–25	6. 3+	. 08	7. 3–7. 9	None	Low	Low.
70–95	50–70	5–12	6. 3+	. 03	6. 6–7. 3	None	Low	Low.
100	95–100	50–75	0. 63–2. 0	. 14	6. 1–7. 3	None	Low	Moderate to low.
100	95–100	55–75	0. 63–2. 0	. 13	7. 4–8. 0	None	Low	Moderate.
---------	100	25–40	2. 0–6. 3	. 10	7. 4–8. 0	None	Low	Low.
95–100	90–100	55–70	0. 63–2. 0	. 16	6. 1–7. 3	None	Low	Low to moderate.
---------	100	20–35	2. 0–6. 3	. 12	6. 1–7. 3	None	Low	Low.
100	98–100	15–25	6. 3+	. 07	6. 1–7. 9	None	Low	Low.
---------	100	30–45	2. 0–6. 3	. 12	6. 1–7. 3	None	Low	Low.
97–100	94–98	55–75	0. 2–2. 0	. 17	7. 4–8. 4	None	Low	Moderate.
---------	100	20–40	2. 0–6. 3	. 13	6. 1–7. 3	None	Low	Low.
---------	100	20–40	2. 0–6. 3	. 12	6. 1–7. 3	None	Low	Low.
---------	100	20–55	2. 0–6. 3	. 11	7. 9–8. 4	None	Low	Low.

TABLE 8.—*Estimated properties*

Soil series and map symbols	Depth to seasonally high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Embden, silty substratum: En	[1]	0–40	Fine sandy loam	SM	A–2–4 or A–4
		40–60	Silty clay loam	CL	A–6
Embden, till substratum: Eo. For Gardena part of Eo, see Gardena series.	[1]	0–16	Loam	SM	A–4
		16–30	Fine sandy loam	SM	A–2–4 or A–4
		30–60	Loam or clay loam	CL	A–4 or A–6
Exline: Es, Ex. For Lamoure part of Ex, see Lamoure series.	2–5	0–2	Silt loam	CL	A–4 or A–6
		2–18	Silty clay loam	CH	A–7
		18–60	Silty clay loam	CL	A–6 or A–7
Fargo: Fc, Fh. For Hegne part of Fh, see Hegne series.	3–5	0–21	Silty clay	CH	A–7
		21–60	Silty clay or clay	CH	A–7
Fargo, sandy substrata	3–5	0–21	Silty clay	CH	A–7
		21–36	Silty clay	CH	A–7
		36–60	Coarse sand and gravel	SP–SM	A–1–b
Fordville: FvA, FvB	[1]	0–16	Loam	SM or ML	A–4
		16–22	Loam	SM or ML	A–4
		22–60	Coarse sand and gravel	SP–SM	A–1–b
Gardena: Ga, GaB, GeA. For Eckman part of GeA, see Eckman series.	[1]	0–25	Loam	ML or ML–CL or CL	A–4 or A–6
		25–60	Silt loam, loam, or very fine sandy loam.	CL or ML	A–4 or A–6
Gardena, silty substratum: Gb	3–5	0–25	Loam	ML	A–4
		25–40	Silt loam	ML–CL	A–4 or A–6
		40–60	Clay loam or silty clay loam	CL	A–6
Gardena, till substratum: Gc	3–5	0–36	Loam	ML	A–4
		36–60	Loam	CL	A–6
Glyndon: Gl, GlB, Gm	2–5	0–40	Silt loam	ML or CL or ML–CL	A– or A–6
		40–60	Loamy fine sand	SM	A–2–4
Glyndon, silty substratum: Gn	2–5	0–40	Loam	ML	A–4
		40–60	Silty clay loam	CL	A–6
Grano: Go	0–3	0–60	Silty clay	CH	A–7
Great Bend: GrB, GtA, GtB. For Barnes part of GtA and GtB, see Barnes series.	[1]	0–18	Silty clay loam	CL	A–6
		18–60	Silty clay loam or silt loam	CL	A–6
Hamar: Ha, He	2–5	0–60	Loamy fine sand or fine sand	SM	A–2–4
Hamerly: Hf, Hg. For Svea part of Hg, see Svea series.	2–5	0–60	Loam and clay loam	CL	A–6
Hecla: Hh, Hl, HlB, Hn, HoA, HoB, HuA, HuB, Hv. For Hamar part of Hn, HoA, and HoB, see Hamar series; for Ulen part of HuA, HuB, and Hv, see Ulen series.	3–5	0–18	Fine sandy loam or loamy fine sand.	SM	A–2–4 or A–4
		18–60	Loamy fine sand, fine sand	SM	A–2–4
Hecla, silty substratum: Hk, Hm	3–5	0–40	Fine sandy loam or loamy fine sand.	SM	A–2–4
		40–60	Silty clay loam	CL	A–6 or A–7
Hegne	3–5	0–60	Silty clay	CH	A–7

See footnotes at end of table.

of the soils—Continued

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH*			
	100	20–40	2. 0–6. 3	. 12	6. 1–7. 3	None	Low	Low.
	100	80–95	0. 20–0. 6	. 17	7. 9–8. 4	None	Low	Moderate.
	100	35–50	0. 63–6. 3	. 14	6. 1–7. 3	None	Low	Low.
	100	20–40	2. 0–6. 3	. 12	6. 1–7. 3	None	Low	Low.
97–100	94–98	55–75	0. 2–2. 0	. 17	7. 4–8. 4	None	Low	Moderate.
	100	55–75	0. 63–2. 0	. 16	6. 1–6. 5	None	Low	Moderate.
	100	90–95	0. 00–0. 06	. 18	7. 4–7. 9	Severe	High	High.
	100	70–80	0. 2–0. 63	. 17	7. 9–8. 4	Severe	Moderate	Moderate.
	100	90–100	0. 05–0. 20	. 20	6. 1–7. 3	None	Low	High.
	100	90–100	0. 05–0. 20	. 20	7. 4–8. 4	None	Low	High.
	100	90–100	0. 05–0. 20	. 20	6. 1–7. 3	None	Low	High.
	100	90–100	0. 05–0. 20	. 20	7. 4–8. 4	None	Low	High.
55–80	45–60	5–10	6. 3+	. 02	7. 4–7. 9	None	Low	Low.
98–100	95–100	40–65	0. 63–2. 0	. 15	7. 6–7. 8	None	Low	Low.
98–100	95–100	40–65	0. 63–2. 0	. 14	7. 4–8. 0	None	Low	Low.
55–80	45–60	5–10	6. 3+	. 02	7. 9–8. 4	None	Low	Low.
	100	70–90	0. 63–2. 0	. 17	6. 6–7. 3	None	Low	Low to moderate.
	100	70–95	0. 63–2. 0	. 17	7. 4–8. 0	None	Low	Low to moderate.
	100	55–75	0. 63–2. 0	. 15	6. 6–7. 3	None	Low	Low to moderate.
	100	80–95	0. 63–2. 0	. 16	7. 4–8. 0	None	Low	Moderate.
100	95–100	70–95	0. 05–0. 63	. 17	7. 4–7. 8	None	Low	Moderate.
100	95–100	50–70	0. 63–2. 0	. 15	6. 6–7. 3	None	Low	Low to moderate.
97–100	90–100	60–75	0. 2–2. 0	. 17	7. 4–8. 0	None	Low	Moderate.
	100	60–90	0. 63–2. 0	. 16	7. 4–8. 4	None [2]	Low	Low to moderate.
	100	15–25	6. 3+	. 07	7. 5–8. 0	Slight	Low	Low.
	100	60–75	0. 63–2. 0	. 16	7. 4–8. 4	None	Low	Low to moderate.
	100	90–95	0. 2–0. 63	. 17	7. 9–8. 4	None	Low	Moderate.
	100	90–100	0. 05–0. 20	. 20	7. 9–8. 4	None	Low	High.
98–100	15–100	75–90	0. 2–2. 0	. 17	6. 6–7. 3	None	Low	Moderate.
98–100	95–100	75–90	0. 2–2. 0	. 17	7. 9–8. 4	None	Low	Moderate.
	100	15–25	6. 3+	[3]	6. 6–7. 3	None	Low	Low.
97–100	95–98	60–80	0. 2–2. 0	. 17	7. 9–8. 4	None or slight	Low	Moderate.
	100	25–40	2. 0–6. 3	. 13	6. 6–7. 3	None	Low	Low.
	100	15–25	6. 3+	. 07	6. 6–7. 3	None	Low	Low.
	100	15–25	6. 3+	. 08	6. 6–7. 3	None	Low	Low.
	100	90–95	0. 2–0. 63	. 17	7. 4–7. 8	None	Low	Moderate.
	100	90–100	0. 05–0. 20	. 20	7. 9–8. 4	None	Low	High.

TABLE 8.—*Estimated properties*

Soil series and map symbols	Depth to seasonally high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Hegne, sandy substrata: Hx	3–5	0–36	Silty clay	CH	A–7
		36–60	Coarse sand and gravel	SP–SM	A–1–b
LaDelle: La, Lc	(1)	0–60	Silt loam or silty clay loam	ML–CL	A–6
LaDelle, clayey substratum: Ld	(1)	0–36	Silt loam or silty clay loam	ML–CL or CL	A–6
		36–60	Clay	CH	A–7
Lamoure: Le, Lf	2–5	0–60	Silty clay loam	CL	A–6 or A–7
LaPrairie: Lg, Ll, Lm. For Lamoure part of Lm, see Lamoure series.	(1)	0–60	Silt loam	ML–CL	A–6
Letcher: Ln	2–5	0–8	Fine sandy loam	SM	A–2–4
		8–28	Sandy clay loam or fine sandy loam.	SC or CL	A–6
		28–60	Fine sandy loam	SM	A–2–4
Ludden: Lu, Lw, Ly. For Ryan part of Ly, see Ryan series.	0–5	0–24	Silty clay	CH	A–7
		24–60	Silty clay	CH	A–7
Maddock: MaA, MaB, MbC, McB, MhB, Mk3, MmB. For Barnes part of MbC, see Barnes series; for Hecla part of McB, MhB, Mk3, and MmB, see Hecla series.	(1)	0–8	Fine sandy loam or loamy fine sand.	SM	A–2–4 or A–4
		8–60	Loamy fine sand	SM	A–2–4
Nutley: NuA, NuB, Ny. For Fargo part of Ny, see F rgo series.	(1)	0–20	Silty clay	CH	A–7
		20–60	Silty clay	CH	A–7
Overly: Oe, Or. For Aberdeen part of Or, see Aberdeen series.	4–5	0–10	Silt loam	ML–CL	A–4 or A–6
		10–32	Silty clay loam	CL	A–6 or A–7
		32–60	Silty clay loam	CL	A–6
Parnell: Pa	0–3	0–18	Silty clay loam	CH	A–7
		18–60	Clay loam	CH	A–7
Perella: Pr	0–3	0–23	Loam	ML or CL	A–4 or A–6
		23–60	Silt loam or silty clay loam	ML–CL or CL	A–6
Rauville: Ra, RaC	0–2	0–48	Silt loam or silty clay loam	ML-CL	A–6
		[4] 48–60	Coarse sand to silty clay	ML-CL	A–6
Renshaw: ReA, ReB, RsA, RsB. For Sioux part of RsA and RsB, see Sioux series.	(1)	0–18	Loam	SM or ML	A–4
		18–60	Coarse sand and gravel	SP–SM	A–1–b
Ryan: Ru, Ry	0–5	0–2	Silty clay loam	CL	A–6
		2–60	Silty clay	CH	A–7
Sioux: So	(1)	0–6	Loam or sandy loam	SM or ML	A–4 or A–2–4
		6–60	Coarse sand and gravel	SP–SM	A–1–b
Spottswood: Sp	(1)	0–30	Loam	SM or ML	A–4
		30–60	Coarse sand and gravel	SP–SM	A–1–b
Stirum: Sr, Ss, St, Su. For Exline part of St, see Exline series; for Letcher part of Su, see Letcher series.	0–3	0–6	Fine sandy loam	SM	A–2–4
		6–38	Fine sandy loam, sandy loam, and loamy fine sand.	SM, SC, or CL	A–4
		38–60	Loamy fine sand and silt loam:		
			Loamy fine sand part	SM	A–2–4
			Silt loam part	ML	A–6

See footnotes at end of table.

of the soils—Continued

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH*			
---------	100	90–100	0. 05–0. 20	. 20	7. 9–8. 4	None	Low	High.
55–80	45–60	5–10	6. 3+	. 02	7. 4–7. 9	None	Low	Low.
---------	100	70–95	0. 2–2. 0	. 17	6. 6–7. 9	None	Low	Low to moderate.
---------	100	70–95	0. 2–2. 0	. 17	6. 6–7. 9	None	Low	Low to moderate.
---------	100	95–100	0. 05–0. 20	. 20	6. 6–7. 9	None	Low	High.
---------	100	80–95	0. 2–0. 63	. 18	7. 4–8. 4	None or slight	Low	Moderate.
---------	100	70–90	0. 63–2. 0	. 17	6. 6–7. 9	None	Low	Low to moderate.
---------	100	25–35	2. 0–6. 3	. 12	6. 1–6. 5	None	Low	Low.
---------	100	40–50	0. 05–0. 63	. 12	7. 9–8. 4	Moderate	Moderate	Low to moderate.
---------	100	25–35	2. 0–6. 3	. 06	7. 9–8. 4	Moderate	Low	Low.
---------	100	90–100	0. 05–0. 20	. 20	6. 1–7. 3	None	Low	High.
---------	100	90–100	0. 05–0. 20	. 20	7. 4–8. 4	None to moderate	Low	High.
---------	100	25–40	2. 0–6. 3	. 12	6. 6–7. 3	None	Low	Low.
---------	100	15–25	6. 3+	. 07	6. 6–7. 3	None	Low	Low.
---------	100	95–100	0. 05–0. 20	. 20	6. 6–7. 8	None	Low	High.
---------	100	80–95	0. 05–0. 20	. 20	7. 9–8. 4	None or slight	Low	High.
---------	100	70–90	0. 63–2. 0	. 17	6. 6–7. 3	None	Low	Low to moderate.
---------	100	80–95	0. 20–0. 63	. 18	6. 6–7. 3	None	Low	Moderate.
---------	100	80–95	0. 20–0. 63	. 18	7. 9–8. 4	None or slight	Low	Moderate.
---------	100	90–95	0. 20–0. 63	. 18	6. 6–7. 3	None	Low	High.
95–100	90–100	65–85	0. 06–0. 20	. 17	7. 9–8. 4	None	Low	High.
---------	100	60–90	0. 63–2. 0	. 16	6. 6–7. 3	None	Low	Low to moderate.
---------	100	70–95	0. 06–0. 20	. 18	7. 9–8. 4	None	Low	Moderate.
---------	100	70–95	0. 20–2. 0	. 17	7. 4–7. 9	None to moderate	Low	Moderate.
100	100	70–95	0. 20–0. 63	. 17	7. 9–8. 4	Slight	Low	Moderate.
98–100	95–100	40–65	0. 63–2. 0	. 15	6. 6–7. 3	None	Low	Low.
55–80	45–60	5–10	6. 3+	. 02	7. 9–8. 4	None	Low	Low.
---------	100	80–95	0. 20–0. 63	. 16	6. 6–7. 3	None	Low to moderate.	Moderate.
---------	100	90–100	0. 00–0. 06	. 20	7. 9–8. 4	Very severe	Moderate	High.
98–100	95–100	24–55	0. 63–6. 3	. 12	6. 6–7. 3	None	Low	Low.
55–80	45–60	5–10	6. 3+	. 02	7. 9–8. 4	None	Low	Low.
98–100	95–100	40–65	0. 63–2. 0	. 15	6. 6–7. 3	None	Low	Low.
55–80	45–60	5–10	6. 3+	. 02	7. 9–8. 4	None	Low	Low.
---------	100	25–35	2. 0–6. 3	. 12	7. 9–8. 4	None	Low	Low.
---------	100	40–55	0. 05–0. 63	. 14	8. 5–9. 0	Moderate	Moderate	Low to moderate.
---------	100	15–35	6. 3+	. 07	7. 9–8. 4	Moderate	Low	Low.
---------	100	70–90	0. 05–0. 63	. 18	7. 9–8. 4	Moderate	Low	Moderate.

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TABLE 8.—*Estimated properties*

Soil series and map symbols	Depth to seasonally high water table	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
	Feet	*Inches*			
Svea: Sv, Sw	4–5	0–21	Loam	CL	A-4 or A-6
		21–60	Loam, clay loam	CL	A-4 or A-6
Tiffany: Tf, Tn	2–5	0–60	Fine sandy loam, loam, or fine sand.	SM or ML	A-2-4 or A-4
Tiffany, silty substratum: Tg	2–5	0–40	Fine sandy loam or loam	SM	A-2-4
		40–60	Silty clay loam	CL	A-6
Tonka: To, Tp. For Parnell part of Tp, see Parnell series.	0–5	0–11	Silt loam	ML-CL	A-6
		11–60	Silty clay loam or clay loam	CL	A-6 or A-7
Ulen: Ue, Uh. For Hamar part of Uh, see Hamar series.	2–5	0–20	Fine sandy loam	SM	A-2-4
		20–60	Loamy fine sand or fine sand	SM	A-2-4
Ulen, silty substratum: Uf	2–5	0–20	Fine sandy loam	SM	A-2-4
		20–40	Loamy fine sand or fine sand	SM	A-2-4
		40–60	Silty clay loam	CL	A-6
Vallers: Va	1–3	0–8	Silty clay loam	CL	A-6
		8–60	Loam or clay loam	CL	A-6
Venlo: Ve	0–3	0–24	Fine sandy loam	SM	A-2-4
		24–60	Loamy fine sand	SM	A-2

[1] More than 5 feet.
[2] Salinity is moderate throughout the profile in one mapping unit in this series.

of the soils—Continued

Percentage passing sieve—			Permea-bility	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch of soil*	*pH*			
96–100	95–98	55–75	0. 63–2. 0	. 16	6. 6–7. 3	None	Low	Moderate.
96–100	95–98	55–75	0. 2–2. 0	. 17	7. 9–8. 4	None or moderate	Low	Moderate.
---------	100	25–70	0. 63–6. 3	. 14	6. 6–7. 8	None	Low	Low.
---------	100	25–35	2. 0–6. 3	. 12	6. 6–7. 3	None	Low	Low.
---------	100	90–95	0. 2–0. 63	. 18	7. 4–7. 8	None	Low	Moderate.
---------	100	70–90	0. 63–2. 0	. 17	5. 6–6. 5	None	Low	Low to moderate.
96–100	95–100	65–85	0. 2–0. 63	. 17	6. 6–7. 8	None	Low	Moderate.
---------	100	25–35	2. 0–6. 3	. 12	7. 9–8. 4	None	Low	Low.
---------	100	15–25	6. 3+	. 08	7. 9–8. 4	None	Low	Low.
---------	100	25–35	2. 0–6. 3	. 12	7. 9–8. 4	None	Low	Low.
---------	100	15–25	6. 3+	. 08	7. 9–8. 4	None	Low	Low.
---------	100	90–95	0. 2–0. 63	. 17	7. 9–8. 4	None	Low	Moderate.
---------	100	80–95	0. 2–0. 63	. 18	7. 9–8. 4	None	Low	Moderate.
95–100	90–95	55–80	0. 06–0. 20	. 17	7. 9–8. 4	None or slight	Low	Moderate.
---------	100	25–35	2. 0–6. 3	. 12	6. 6–7. 3	None	Low	Low.
---------	100	15–25	6. 3+	. 07	6. 6–7. 3	None	Low	Low.

[3] Available water capacity is 0.07 for loamy fine sand and 0.12 for fine sandy loam.
[4] Properties of this layer are variable.

TABLE 9.—*Engineering*

[Interpretations are not given for Fresh water marsh; Gravel pits; Loamy lake beaches; Peat and

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds: Reservoir area	Farm ponds: Embankments
Aberdeen: Ab, Ae. For Exline part of Ae, see Exline series.	Very good in uppermost 8 inches.	Unsuitable	Poor to very poor.	High susceptibility to frost heaving; highly plastic.	All features favorable.	Fair stability; fair compaction; medium to high compressibility.
Arveson: Af, An	Fair: high water table.	Unsuitable for gravel; poor for sand; excessive fines.	Good	Seasonally high water table.	High water table; suitable for dugouts.	Fair stability and compaction; semipervious; hazard of piping.
Arvilla: ArA, ArB	Good in uppermost 7 inches; fair to a depth of 15 inches.	Good for sand; good source of gravel for asphalt; poor for concrete; high content of shale and limestone.	Fair to good in uppermost 15 inches; very good in substratum.	All features favorable.	Rapid seepage; slow runoff.	Sandy material; rapid seepage; poor resistance.
Barnes: BaC, BaC2, BbC, BbD, Bc, Be, BgA, BhC, BnB. For Buse part of BbC and BbD, see Buse series; for Cresbard part of Bc, see Cresbard series; for Gardena and Eckman parts of BgA, see their respective series; for Renshaw part of BhC, see Renshaw series; for Svea part of BnB, see Svea series.	Very good in uppermost 6 to 8 inches; fair below a depth of 8 inches; poor where soil material is stony loam.	Unsuitable	Fair to poor	Scattered potholes or large stones; subject to frost heaving.	All features favorable.	All features favorable.
Bearden: Bo, Br, Bs. For Exline part of Bs, see Exline series.	Very good in uppermost 12 inches.	Unsuitable	Poor	High susceptibility to frost heaving; seasonally high water table.	Fluctuating seasonally high water table; may be suitable for dug ponds.	Fairly stable and impervious when compacted.
Borup: Bt, Bu	Good: high water table.	Unsuitable	Fair in surface layer; good in substratum.	Seasonally high water table; high susceptibility to frost heaving.	High water table; suitable for dug ponds.	Fairly stable and impervious when compacted.

See footnote at end of table.

interpretations

muck, shallow; and Saline land. These land types have a wide range in characteristics]

Soil features affecting				Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields	
Terraces and diversions	Agricultural drainage	Irrigation	Waterways		Septic tanks	Lagoons
Not applicable	Slow permeability	Very slow intake rate; susceptible to salt accumulation; moderately shallow rooting depth.	Dense, silty clay loam subsoil; difficult to construct or vegetate waterways.	Fair to poor: fair bearing capacity; moderate to high shrink-swell potential; fair to poor shear strength.	Severe: slow permeability.	All features favorable.
Not applicable	Seasonally high water table; moderately rapid to rapid permeability; difficult to locate outlets.	Drainage needed; rapid permeability.	Not applicable	Poor: high water table.	Moderate: occasional high water table.	Severe: rapid permeability.
Shallow to sand and gravel.	Not applicable	Low available water capacity; rapid intake rate; unstable for ditches.	Shallow to sand and gravel; low stability; difficult to vegetate.	Good: low shrink-swell potential.	Moderate: danger of polluting wells.	Severe: rapid seepage.
Short slopes	Not applicable	Moderately slow permeability in substratum; susceptible to salt accumulation; short slopes.	All features favorable.	Fair: moderate to high shrink-swell potential.	Slight to moderate: slope.	Moderate: slope and moderately slow permeability.
Not applicable	Seasonally high water table; slow permeability.	Drainage needed; seasonally high water table.	All features favorable.	Fair: moderate shrink-swell potential.	Moderate to severe: slow permeability; occasional high water table.	Moderate: slow permeability and fair embankment material.
Not applicable	Seasonally high water table; moderate permeability; difficult to locate outlets.	Drainage needed; high water table.	Not applicable	Poor: high water table.	Severe: high water table.	All features favorable.

TABLE 9.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankments
Buse: BvE	Very good in uppermost 3 to 6 inches; fair below a depth of 6 inches.	Unsuitable	Fair to poor	Steep; scattered large stones.	All features favorable.	All features favorable.
Cavour: Ca	Poor: high clay content.	Unsuitable	Poor	Unstable material; high susceptibility to frost heaving.	All features favorable.	Dispersed material; low stability.
Claire: Ce	Fair in uppermost 9 inches.	Good for sand; fair for gravel.	Good	Subject to erosion.	Rapid seepage; slow runoff.	Sandy material; rapid seepage.
Colvin: Ch, Co, Cs	Good: high water table.	Unsuitable	Poor	Seasonally high water table; high susceptibility to frost heaving; potholes and seepage areas.	High water table; suitable for dug ponds.	Fair stability; impervious when compacted.
Cresbard: Cu, Cv. For Cavour part of Cu and Cv, see Cavour series.	Very good in uppermost 6 to 8 inches.	Unsuitable	Fair to poor	Low stability in uppermost 2 feet.	All features favorable.	Fair stability; impervious when compacted.
Divide: Dd	Very good	Fair for sand; good source of gravel for asphalt; poor for concrete; high content of shale and limestone; seasonally high water table hinders excavation.	Fair in surface layer; very good in substratum.	Seasonally high water table.	Rapid seepage	Rapid permeability when compacted; hazard of piping.
Eckman: EaA, EaB, EaC.	Very good	Unsuitable	Fair	All features favorable.	All features favorable except where underlain by sand.	All features favorable.
Edgeley: EbA, EbB	Very good in uppermost 7 inches; fair below a depth of 7 inches.	Unsuitable	Fair; good in substratum.	Bedded shale below a depth of 2½ to 4 feet.	Holds water well.	Substratum is shale; poor because compacted weight of soil material is so light that excessive amount of soil is needed to construct stable embankment.

See footnote at end of table.

interpretations—Continued

Soil features affecting: Terraces and diversions	Soil features affecting: Agricultural drainage	Soil features affecting: Irrigation	Soil features affecting: Waterways	Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields: Septic tanks	Degree of limitation for sewage disposal fields: Lagoons
Short slopes	Not applicable	Steep slopes	Steep; difficult to vegetate.	Fair: moderate to high shrink-swell potential.	Moderate to severe: slope.	Severe: steep.
Not applicable	Not applicable	Very slow intake rate; high salt content; shallow rooting depth.	Dense, silty clay loam to silty clay subsoil; difficult to vegetate.	Poor: unstable; moderate to high shrink-swell potential.	Severe: very slow permeability.	Moderate: unstable embankment material.
Not applicable	Not applicable	Very low available water capacity; rapid intake rate.	Not applicable	Good: low shrink-swell potential.	Moderate: danger of pollution to wells.	Severe: rapid seepage.
Not applicable	Seasonally high water table; occasional surface ponding; moderately slow permeability; difficult to locate outlets.	Drainage needed; high water table.	Not applicable	Poor: high water table.	Severe: high water table.	All features favorable.
Not applicable	Not applicable	Slow intake rate; susceptible to salt accumulation; moderately shallow rooting depth.	Dense, clay loam subsoil; difficult to vegetate.	Fair to poor: moderate to high shrink-swell potential.	Moderate to severe: slow permeability.	Slight to moderate: fair stability of embankment material.
Not applicable	Seasonally high water table; moderately rapid permeability.	Drainage needed; seasonally high water table; low available water capacity.	Low stability; difficult to vegetate.	All features favorable.	Moderate: danger of polluting wells.	Severe: rapid seepage.
Some slopes are steep.	Not applicable	Gravity system on flatter slopes; sprinkler system on steeper slopes.	Steeper slopes difficult to vegetate.	Fair: moderate shrink-swell potential.	Slight to moderate: slope.	Moderate on flatter slopes; severe on steeper slopes: permeability.
Short slopes	Not applicable	Impervious bedded shale below a depth of 3 feet; susceptible to salt accumulation.	Deep cuts expose shale; difficult to vegetate.	Fair: low shrink-swell potential.	Severe: slow permeability in substratum.	All features favorable.

TABLE 9.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds: Reservoir area	Farm ponds: Embankments
Egeland: EcC, EdA, EdB, EeB, EgA, EgB. For Embden part of EgA and EgB, see Embden series.	Very good	Unsuitable for gravel; fair to good for sand; excessive fines in some areas.	Good	Subject to erosion.	Rapid seepage	Sandy material; rapid seepage; subject to piping.
Embden: Em, En, Eo For Gardena part of Eo, see Gardena series.	Very good	Unsuitable for gravel; fair for sand; excessive fines.	Good	Subject to erosion.	Rapid seepage	Sandy material; rapid seepage; subject to piping.
Exline: Es, Ex For Lamoure part of Ex, see Lamoure series.	Poor: high clay content.	Unsuitable	Poor to very poor.	Highly plastic; high susceptibility to frost heaving; seasonally high water table.	All features favorable.	Dispersed material; low stability.
Fargo: Fc, Fh For Hegne part of Fh, see Hegne series.	Fair: high clay content.	Unsuitable	Very poor	Highly plastic; high susceptibility to frost heaving.	All features favorable.	Clayey material; high volume change; impervious.
Fordville: FvA, FvB	Very good	Fair for sand; good source of gravel for asphalt; poor for concrete; high content of shale and limestone.	Fair in uppermost 2 to 3 feet; very good in substratum.	All features favorable.	Material too porous to hold water.	Sandy material; poor stability; rapid seepage; poor resistance to piping.
Gardena: Ga, GaB, Gb, Gc, GeA For Eckman part of GeA, see Eckman series.	Very good	Unsuitable	Fair to poor	All features favorable.	All features favorable except where underlain by sand.	Fair to good stability.
Glyndon: Gl, GlB, Gm, Gn.	Very good	Unsuitable	Fair to good in surface layer; good to poor in substratum.	Seasonally high water table; subject to frost heaving.	Moderate seepage in uppermost 3 feet; seasonally high water table.	All features favorable.
Grano: Go	Fair: high clay content; occasionally flooded.	Unsuitable	Very poor	Highly plastic; high susceptibility to frost heaving; occasionally flooded.	Impervious; holds water well.	Difficult to work; poor stability; high compressibility.
Great Bend: GrB, GtA, GtB. For Barnes part of GtA and GtB see Barnes series.	Very good	Unsuitable	Poor	A few potholes; subject to frost heaving.	All features favorable.	Fairly stable and impervious when compacted.

See footnote at end of table.

interpretations—Continued

Soil features affecting				Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields	
Terraces and diversions	Agricultural drainage	Irrigation	Waterways		Septic tanks	Lagoons
Short slopes	Not applicable	Rapid intake rate; sprinkler system on steeper slopes.	Not applicable	Good: low shrink-swell potential.	All features favorable.	Severe: rapid permeability.
Not applicable	Not applicable	Rapid intake rate	Not applicable	Good: low shrink-swell potential.	All features favorable.	Severe: rapid permeability.
Not applicable	Very slow permeability; seasonally high water table.	Slow intake rate	All features favorable.	Poor: high shrink-swell potential.	Severe: very slow permeability.	Slight to moderate: poor embarkment stability.
Not applicable	Subject to surface ponding; slow permeability.	Slow intake rate; danger of salt accumulation.	All features favorable.	Poor: high shrink-swell potential.	Severe: slow permeability.	All features favorable.
Not applicable	Not applicable	Rapid intake rate; low available water capacity.	Not applicable	Good: low shrink-swell potential.	All features favorable.	Severe: rapid permeability.
All features favorable.	Not applicable	Can be leveled	All features favorable.	Fair: poor shear strength.	Moderate: moderate permeability.	Moderate: moderate permeability.
All features favorable.	Seasonally high water table; moderate permeability.	Can be leveled; seasonally high water table.	All features favorable.	Fair: seasonally high water table.	Moderate: seasonally high water table.	Severe: rapid permeability in substratum.
Not applicable	Subject to frequent surface ponding; slow permeability; difficult to locate outlets.	Very slow intake rate.	Dense, clayey subsoil; difficult to construct.	Poor: high shrink-swell potential.	Severe: slow permeability; frequently flooded.	Moderate: embankment material.
Not applicable	Not applicable	Slow intake rate; easily leveled.	Not applicable	Fair: moderate shrink-swell potential.	Severe: moderately slow permeability.	Slight to moderate: fair embankment. material.

TABLE 9.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankments
Hamar: Ha, He	Poor where soil material is loamy sand; good where soil material is sandy loam; high water table.	Unsuitable for gravel; poor for sand; excessive fines.	Good	Seasonally high water table; subject to wind erosion.	High water table.	Poor resistance to piping.
Hamerly: Hf, Hg. For Svea part of Hg, see Svea series.	Good	Unsuitable	Poor	Subject to frost heaving; seasonally high water table.	Seasonally high water table; holds water.	All features favorable.
Hecla: Hh, Hk, Hl, HlB, Hm, Hn, HoA, HoB, HuA, HuB, Hv. For Hamar part of Hn, HoA, and HoB, see Hamar series; for Ulen part of HuA, HuB, and Hv, see Ulen series.	Good where soil material is sandy loam; poor where soil material is loamy sand.	Unsuitable for gravel; fair for sand; some fines.	Good	Subject to erosion.	Rapid seepage	Sandy material; rapid seepage; subject to piping.
Hegne: Hx	Fair: high clay content.	Unsuitable	Very poor	Highly plastic; high susceptibility to frost heaving.	All features favorable.	Clayey material; high volume change; impervious.
LaDelle: La, Lc, Ld	Very good	Unsuitable	Poor	Susceptible to frost heaving.	All features favorable.	All features favorable.
Lamoure: Le, Lf	Good: occasionally flooded.	Unsuitable	Poor to very poor.	Seasonally high water table; subject to flooding; highly susceptible to frost heaving.	Holds water well.	Fair stability; compaction difficult when wet.
LaPrairie: Lg, Ll, Lm. For Lamoure part of Lm, see Lamoure series.	Very good	Unsuitable	Poor	Susceptible to frost heaving.	All features favorable.	All features favorable.
Letcher: Ln	Good in uppermost 5 to 10 inches; fair below a depth of 10 inches.	Unsuitable for gravel; fair for sand in substratum; some fines.	Fair to good in uppermost 2 feet; good in substratum.	Seasonally high water table; subject to frost heaving; subject to erosion.	Seasonally high water table; rapid seepage.	Sandy material; rapid seepage; poor resistance to piping.
Ludden: Lu, Lw, Ly. For Ryan part of Ly, see Ryan series.	Fair: high clay content.	Unsuitable	Very poor	Highly plastic; highly susceptible to frost heaving; occasionally flooded.	Impervious; holds water well.	Fair stability; poor workability; highly compressible.

See footnote at end of table.

interpretations—Continued

Soil features affecting: Terraces and diversions	Soil features affecting: Agricultural drainage	Soil features affecting: Irrigation	Soil features affecting: Waterways	Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields: Septic tanks	Degree of limitation for sewage disposal fields: Lagoons
Not applicable	Seasonally high water table; rapid permeability; difficult to locate outlets.	Drainage needed; rapid intake rate.	Not applicable	Fair: high water table.	Moderate: seasonally high water table.	Severe: rapid permeability.
Short slopes	Seasonally high water table; moderate permeability.	Drainage needed	All features favorable.	Fair: moderate shrink-swell potential.	Moderate to severe: moderately slow permeability.	Moderate: moderately slow permeability.
Not applicable	Not applicable	Rapid intake rate; low available water capacity.	Not applicable	Good: low shrink-swell potential.	Slight: no limiting factors.	Severe: rapid permeability.
Not applicable	Su ject to surface ponding; slow permeability.	Slow intake rate; danger of salt accumulation.	All features favorable.	Poor: high shrink-swell potential.	Severe: slow permeability.	All features favorable.
All features favorable.	Not applicable	Moderate intake rate; high available water capacity.	All features favorable.	Fair: low to moderate shrink-swell potential.	Moderate to severe: moderate to moderately slow permeability.	Moderate: moderate permeability.
All features favorable.	Seasonally high water table; subject to stream overflow; moderately slow permeability.	High water table	All features favorable.	Poor: high water table.	Severe: slow permeability; high water table.	All features favorable.
All features favorable.	Not applicable	Moderate intake rate; high available water capacity.	All features favorable.	Fair: low to moderate shrink-swell potential.	Moderate: moderate permeability.	Moderate: moderate permeability.
Sandy material; highly erodible; difficult to vegetate.	Seasonally high water table; slow permeability in subsoil.	Seasonally high water table; low available water capacity.	Sandy material; highly erodible; difficult to vegetate.	Fair: seasonally high water table.	Moderate: seasonally high water table.	Severe: rapid permeability.
Not applicable	Subject to surface ponding; slow permeability.	Very slow intake rate.	All features favorable.	Poor: high shrink-swell potential; occasionally flooded.	Severe: slow permeability; occasionally flooded.	All features favorable.

TABLE 9.—*Engineering*

Soil series and map symbols	Suitability as a source of— Topsoil	Sand and gravel	Road fill	Soil features affecting— Highway location	Farm ponds: Reservoir area	Farm ponds: Embankments
Maddock: MaA, MaB, MbC, McB, MhB, Mk3, MmB. For Barnes part of MbC, see Barnes series; for Hecla part of McB, MhB, Mk3, and MmB, see Hecla series.	Good where soil material is sandy loam; poor where soil material is loamy sand.	Unsuitable for gravel; good for sand; some fines.	Good	Subject to erosion.	Material too porous to hold water.	Sandy material; rapid seepage.
Nutley: NuA, NuB, Ny. For Fargo part of Ny, see Fargo series.	Good: high clay content.	Unsuitable	Very poor	Highly plastic; highly susceptible to frost heaving.	All features favorable.	Clayey material; poor workability; high volume change.
Overly: Oe, Or. For Aberdeen part of Or, see Aberdeen series.	Very good	Unsuitable	Poor	High susceptibility to frost heaving; material is plastic.	All features favorable.	Fairly stable and impervious when compacted.
Parnell: Pa	Fair to good: occasionally flooded.	Unsuitable	Very poor	Highly plastic; highly susceptible to frost heaving; frequently ponded.	All features favorable.	Silty clay loam and clay loam material; poor workability; high volume change.
Perella: Pr	Good: high water table.	Unsuitable	Fair to poor in surface layer; poor in substratum.	Highly susceptible to frost heaving; occasionally flooded.	All features favorable.	Fair stability; slow permeability.
Rauville: Ra, RaC	Poor: frequently wet.	Unsuitable	Very poor in surface layer.	High water table; frequently flooded.	Permanent water table within 5 feet of surface.	Fair stability; moderate to slow permeability when compacted.
Renshaw: ReA, ReB, RsA, RsB. For Sioux part of RsA and RsB, see Sioux series.	Good in uppermost 6 inches; fair to a depth of 18 inches.	Fair for sand; good source of gravel for asphalt; poor for concrete; high content of shale and limestone.	Fair to good in uppermost 2 to 3 feet; very good in substratum.	All features favorable.	Rapid seepage; slow runoff.	Sandy material; rapid seepage; poor resistance to piping.
Ryan: Ru, Ry	Poor: high clay content.	Unsuitable	Poor to very poor.	Highly plastic; high susceptibility to frost heaving; seasonal high water table.	All features favorable.	Dispersed material; poor stability.

See footnote at end of table

interpretations—Continued

Soil features affecting				Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields	
Terraces and diversions	Agricultural drainage	Irrigation	Waterways		Septic tanks	Lagoons
Not applicable	Not applicable	Low available water capacity; rapid intake rate.	Not applicable	Good: low shrink-swell potential.	Slight: no limiting factors.	Severe: rapid permeability.
Not applicable	Subject to surface ponding.	Slow intake rate	Not applicable	Poor: high shrink-swell potential.	Severe: slow permeability.	All features favorable.
Not applicable	Not applicable	Slow intake rate; easily leveled.	Not applicable	Fair: moderate shrink-swell potential.	Severe: slow permeability.	Slight to moderate: fair embankment material.
Not applicable	Subject to surface ponding; slow permeability; difficult to locate outlets.	Slow intake rate; drainage needed, but soil is difficult to drain.	Not applicable	Poor: high shrink-swell potential.	Severe: slow permeability.	Moderate: poor embankment material.
Not applicable	Seasonally high water table; moderately slow permeability; difficult to locate outlets.	Moderate intake rate; drainage needed.	Not applicable	Fair: moderate shrink-swell potential.	Severe: slow permeability.	Moderate: fair embankment material.
Not applicable	High water table; frequently flooded; difficult to locate outlets.	Drainage needed, but difficult; slow intake rate.	Not applicable	Fair: moderate shrink-swell potential.	Severe: frequently flooded; high water table.	Severe: occasionally flooded.
Nearly level; low runoff potential; shallow to sand and gravel.	Not applicable	Low available water capacity; rapid intake rate; unstable for ditches.	Shallow to sand and gravel; low stability; difficult to vegetate.	Good: low shrink-swell potential.	Moderate: hazard of polluting wells.	Severe: rapid seepage.
Not applicable	Very slow permeability; seasonally high water table.	Slow intake rate	All features favorable.	Poor: high shrink-swell potential.	Severe: very slow permeability.	Slight to moderate: poor embankment stability.

TABLE 9.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—		
	Topsoil	Sand and gravel	Road fill	Highway location	Farm ponds	
					Reservoir area	Embankments
Sioux: So	Good in uppermost 8 inches.	Fair for sand; good source of gravel for asphalt and concrete; may need washing if used for concrete.	Good in uppermost 12 inches; very good below a depth of 12 inches.	Scattered large stones; thin surface layer.	Material too porous to hold water.	Sandy material; rapid seepage; fair stability; poor resistance to piping.
Spottswood: Sp	Very good	Fair for sand; good source of gravel for asphalt; poor for concrete; high content of shale and limestone.	Fair in uppermost 2 to 3 feet; very good in substratum.	All features favorable.	Material too porous to hold water.	Sandy material; rapid seepage; fair stability; poor resistance to piping.
Stirum: Sr, Ss, St, Su. For Exline part of St, see Exline series; for Letcher part of Su, see Letcher series.	Good in uppermost 6 inches; poor below a depth of 6 inches; high clay content.	Unsuitable for gravel; fair for sand in substratum; some fines; seasonally high water table.	Fair	Seasonally high water table; subject to erosion.	Material too porous to hold water; high water table.	Sandy material; moderate permeability when compacted; fair resistance to piping.
Svea: Sv, Sw	Very good	Unsuitable	Fair to poor	Numerous small potholes; subject to frost heaving; few scattered stones.	All features favorable.	All features favorable.
Tiffany: Tf, Tg, Tn	Good: high water table.	Unsuitable for gravel; poor for sand; excessive fines; seasonally high water table hinders excavation.	Fair to good	Seasonally high water table; occasionally flooded; subject to erosion.	Material too porous to hold water; high water table.	Sandy material; rapid seepage; poor resistance to piping.
Tonka: To, Tp. For Parnell part of Tp, see Parnell series.	Good: occasionally flooded.	Unsuitable	Very poor	Occasionally ponded; highly susceptible to frost heaving.	All features favorable; high water table; occasionally ponded.	Slow permeability when compacted; clayey material; difficult to work when wet.
Ulen: Ue, Uf, Uh. For Hamar part of Uh, see Hamar series.	Good	Unsuitable for gravel; poor for sand; excessive fines; seasonally high water table hinders excavation.	Good	Seasonally high water table; subject to erosion.	Material too porous to hold water; high water table.	Moderate permeability when compacted; poor resistance to piping; fair stability.

See footnote at end of table.

interpretations—Continued

Soil features affecting: Terraces and diversions	Soil features affecting: Agricultural drainage	Soil features affecting: Irrigation	Soil features affecting: Waterways	Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields: Septic tanks	Degree of limitation for sewage disposal fields: Lagoons
Not applicable	Not applicable	Rapid intake rate; low available water capacity.	Not applicable	Good: low shrink-swell potential.	All features favorable.	Severe: rapid permeability.
Not applicable	Not applicable	Rapid intake rate; low available water capacity.	Not applicable	Good: low shrink-swell potential.	All features favorable.	Severe: rapid permeability.
Not applicable	Seasonally high water table; moderate permeability.	Rapid intake rate; low available water capacity; drainage needed.	Not applicable	Good: fair shear strength.	Moderate: seasonally high water table.	Severe: rapid permeability.
Short slopes	Not applicable	Short slopes; moderately slow permeability in substratum.	All features favorable.	Fair: moderate shrink-swell potential.	All features favorable.	Moderate: slope and moderately slow permeability.
Not applicable	Seasonally high water table; moderate permeability; difficult to locate outlets.	Seasonally high water table; rapid intake rate; moderate available water capacity.	Not applicable	Good: low shrink-swell potential.	Moderate: seasonally high water table.	Severe: rapid permeability.
All features favorable.	Subject to surface ponding; slow permeability; difficult to locate outlets.	Seasonally high water table; high available water capacity; slow intake rate.	All features favorable.	Fair: moderate shrink-swell potential.	Severe: slow permeability; seasonally high water table.	Moderate: slow permeability and fair embankment material.
Not applicable	Seasonally high water table; moderately rapid permeability.	Seasonally high water table; rapid intake rate; low available water capacity.	Not applicable	Fair to good: low to moderate shrink-swell potential.	All features favorable.	Severe: rapid permeability in substratum.

TABLE 9.—*Engineering*

Soil series and map symbols	Suitability as a source of— Topsoil	Sand and gravel	Road fill	Soil features affecting— Highway location	Farm ponds: Reservoir area	Farm ponds: Embankments
Vallers: Va	Good: high water table.	Unsuitable	Poor	Seasonally high water table; highly susceptible to frost heaving; scattered large stones.	All features favorable; high water table.	Some clay loam material; fair stability; impervious.
Venlo: Ve	Fair: high water table.	Unsuitable	Fair to good	Frequently ponded; poorly drained.	Frequently ponded; fluctuating water table.	Sandy material; rapid seepage.

[1] Engineers and others should not attempt to apply specific values to the estimates given for bearing capacity of soils.

Parent material

During the Pleistocene period, all of the Survey Area was covered by glaciers. The parent material of the soils of this Area consists mainly of glacial till, glacial melt-water deposits, and postglacial alluvium. Most of the soils developed in friable, calcareous loam or light-gray, loamy till. The till mantle ranges from 1 foot to more than 500 feet in thickness. In most places it is very thick, but in an area south of Edgeley it overlies Cretaceous shale at a depth of 2 to 5 feet.

The deposits left by glacial melt water consist of well-sorted materials carried by water flowing from the melting ice and deposited on outwash plains and terraces, as valley trains, and in glacial lakes. These deposits range from fine sand to clay in texture; in some places they are underlain by coarse sand and gravel. The depth of the glacial melt-water deposits over glacial till ranges from 2 feet or less to more than 5 feet. Some small areas of coarse-textured glacial melt-water deposits have been reworked by wind and deposited as small hummocks or low sand ridges. The soils that developed in glacial melt-water deposits are inextensive compared with those that developed in till parent material, and they are widely distributed throughout the Survey Area.

Most of the bottom-land soils in the Area developed in recent alluvium deposited by streams. These sediments range from sandy loam to clay in texture, and they are commonly stratified. The most extensive deposits of alluvium in the Area are on the floor of the James River Valley. The thickness of the deposits ranges from 25 feet at Grand Rapids to 50 or 60 feet at La Moure. The James River seldom overflows at the present time, and it is probable that much of this alluvium was deposited by melt water flowing from the Mankato ice sheet.

Differences among the soils are partly due to differences in the kinds of parent material in which the soils developed. For example, the soils that developed in loamy glacial till generally have a uniform loam or clay loam texture throughout the profile. Those that developed in glacial melt-water deposits have a wide range of texture. Claypan soils of the Aberdeen, Cavour, Cresbard, Exline, and Ryan series developed in parent material that contained a high percentage of sodium salts.

Climate

This Survey Area has a cool-temperate, dry-subhumid, continental climate characterized by cold, dry winters and warm, relatively moist summers. The average annual precipitation amounts to about 18 inches, and more than 80 percent of it falls during the growing season. Maximum temperatures during the summer months average about 80°F., but temperatures of 90° to 100° are common. In winter the temperature averages about 12°, and in most years snow covers the ground from the first of December until the middle of March. The soil is generally frozen to a depth of 3½ to 4½ feet from November to April.

The principal effect of climate on soil formation in this Area has been the direct influence of rainfall and temperature on the weathering of the parent material, the leaching and accumulation of carbonates, and the accumulation of organic matter in the surface layer. In addition, the climate directly affects the kinds of plant and animal life that can thrive and thus contributes to soil development.

The chemical processes of weathering proceed at a relatively slow rate in this Area, as compared to warmer, more humid parts of the county. Some of the soils, such as those of the Barnes and Edgeley series, are leached of carbonates to a depth of 15 to 30 inches. The precipitation has been sufficient to support the dense stands of tall and mid grasses, under which the soils have developed. This environment has favored the development of dark-colored soils that have a thick, granular surface layer that is rich in organic-matter content. The surface layer grades to a brown or dark-grayish brown subsoil above a zone of lime accumulation.

interpretations—Continued

Soil features affecting: Terraces and diversions	Soil features affecting: Agricultural drainage	Soil features affecting: Irrigation	Soil features affecting: Waterways	Suitability for foundations for low buildings [1]	Degree of limitation for sewage disposal fields: Septic tanks	Degree of limitation for sewage disposal fields: Lagoons
All features favorable.	Seasonally high water table; moderately slow permeability; difficult to locate outlets.	Seasonally high water table; slow intake rate; high available water capacity.	All features favorable.	Fair: moderate shrink-swell potential.	Severe: slow permeability; seasonally high water table.	Slight to moderate: slow permeability.
Many small depressions.	Drainage ditches needed; banks may be unstable.	Drainage needed; high intake rate; low available water capacity; easily leveled.	Sandy material; highly erodible; difficult to vegetate.	Fair: high water table.	Slight: no limiting factors.	Severe: rapid permeability.

Plant and animal life

The native vegetation in the Survey Area consists primarily of short, mid, and tall grasses. Only a few small areas in the James River Valley and some of the steep ravines are wooded. The composition of the native grassland varies with the soils. On the well-drained, nearly level and undulating soils, such as those of the Barnes, Great Bend, Eckman, Egeland, and Maddock series, the native vegetation is mainly tall and mid grasses. The principal species are green needlegrass, bearded wheatgrass, big bluestem, little bluestem, needle-and-thread, and Canada wildrye. Short and mid grasses predominate on the hilly, excessively drained soils. These grasses include little bluestem, plains muhly, side-oats grama, blue grama, and needle-and-thread. On the poorly drained soils, such as those of the Arveson, Borup, Colvin, Grano, Perella, Parnell, Stirum, and Vallers series, the vegetation consists of tall grasses, reeds, rivergrass, slough sedge, American mannagrass, northern reedgrass, and prairie cordgrass.

The principal effects of plant and animal life on soil formation are the accumulation of organic matter and the translocation of plant nutrients from the lower to the upper layers. The native grass vegetation has contributed large amounts of organic matter to the soils. The roots penetrate into the lower horizons, take up calcium, phosphorus, potassium, and other nutrients, then leave these elements near the surface when the plants die and decay. The presence of calcium and the high content of organic matter in the surface layer have favored the development of soils that have granular structure.

Bacteria and fungi play an important role in the development of soils by breaking down undecomposed organic matter and changing it into humus. Some bacteria take nitrogen from the air and change it into a form that can be used by plants. The life processes of earthworms, small rodents, insects, slugs, and snails also influence soil development.

Relief and drainage

Most of the Survey Area is nearly level to undulating, but some areas are rolling to steep. Many poorly drained depressions receive runoff from higher elevations. The steepest areas are the morainic hills in the western part of La Moure County and the breaks of the James River Valley. Local differences in relief range from less than 10 feet in a square mile to 50 to 100 feet in a square mile.

The principal drainage system is the James River and its tributaries. The natural drainage is mainly to the east and south because of the higher elevations in the western part of La Moure County. Much of the Area does not have a well-established drainage system, and runoff collects in poorly drained depressions.

Relief influences the formation of soils through its effect on drainage, runoff, and erosion. Many differences in the soils of this Survey Area result from their topographic position. Among these differences are drainage, thickness of the A horizon and content of organic matter, color and mottling of the subsoil, thickness of the solum, and degree of horizon differentiation.

Runoff is rapid on steep slopes, and only a small percentage of the rainfall penetrates the soil. Under these conditions, there is little moisture for plant growth and soil development. The steep soils are thin and low in organic-matter content, and they have weak horizonation. Examples of these soils are those of the Buse and Sioux series.

Soils on nearly level to rolling slopes are moderately well drained and well drained. There is sufficient moisture to support good stands of mixed native grasses, and the soils have well-developed profiles, characterized by a dark-colored A horizon and a brown to very dark brown B horizon. Examples of these soils are those of the Barnes, Eckman, Egeland, and Maddock series. Most of the moderately well drained soils occur as level or slightly concave areas. They generally have a thicker A horizon, a darker colored B horizon, and a greater depth to lime

than those on convex, undulating or rolling landscapes. Examples of these soils are those of the Embden, Gardena, Hecla, and Svea series.

Concave depressional areas that receive large amounts of runoff from higher elevations have somewhat poor to very poor natural drainage. Most of the soils in these positions are characterized by a black, thick A horizon, a mottled gray or olive subsoil, and substrata like the subsoil. Examples of these soils are those of the Parnell, Perella, Tonka, and Venlo series.

Time

Time is necessary for the factors of soil formation to act on parent material. The length of time for a particular soil to develop depends on the kind of parent material and many other factors.

The soils of this Survey Area range from mature soils that have well-developed profile characteristics to young soils that have little or no horizon differentiation, or profile development. The well-drained soils, such as those of the Barnes series, are among the most mature soils in the Area.

Most differences in profile development result from the combined effects of the other soil-forming factors, rather than the effects of time.

Classification of the Soils

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*, *12*) and later revised. The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and in September 1968 (*14*). This system is under continual study, and readers interested in the development of the system should refer to the latest literature available (*10*).

Table 10 shows the classification of each of the soil series represented in this Survey Area according to the present system, and also the great soil group according to the 1938 system.

Continuing refinement of the soil classification system since publication of the soil survey of adjoining Sargent County in 1964 has resulted in a few differences in classification by soil series. For example, the Tonka series of this survey is the same as the Tetonka series of the Sargent County soil survey.

The current system defines classes in terms of observable or measurable properties of soils. The properties chosen are primarily those that permit the grouping of soils that are similar in genesis. The classification is designed to encompass all soils. It has six categories. Beginning with the most inclusive, they are the order, the suborder, the great group, the subgroup, the family, and the series. These are briefly defined in the following paragraphs.

ORDER.—Ten soils orders are recognized in the current system. These are the Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different climates. Two of the ten soil orders are represented in this Survey Area. These are the Entisols and Mollisols.

Entisols are recent soils in which there has been no horizon development. This order is represented by soils of the Claire series.

Mollisols have a thick, dark-colored surface layer. Most of these soils formed under grass. All of the soils of this Area, except those of the Claire series, are classified as Mollisols.

SUBORDER.—Each order is divided into suborders, primarily on the basis of characteristics that seem to produce classes having genetic similarity. Mainly, these are characteristics that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation. The climatic range is narrower than that of the orders.

GREAT GROUP.—Each suborder is divided into great groups, on the basis of uniformity in the kinds and sequence of major horizons and similarity of the significant features of corresponding horizons. The horizons considered are those in which clay, iron, or humus has accumulated and those that have pans that interfere with the growth of roots or the movement of water. The features selected are the self-mulching properties of clays, soil temperature, chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like.

SUBGROUP.—Each great group is divided into subgroups, one representing the central (typic) segment of the group, and other groups, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order.

FAMILY.—Families are established within a subgroup, primarily on the basis of properties that affect the growth of plants or the behavior of soils in engineering use. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Physical and Chemical Analyses

Data obtained by physical and chemical analyses for selected soils in this Survey Area are given in table 11. Profiles of the selected soils are described in the section entitled "Descriptions of the Soils." Such data are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful for estimating water-holding capacity, erodibility, fertility, tilth, and other properties significant in soil management. The data on reaction, electrical conductivity, and percentage of exchangeable sodium are helpful in evaluating the possibility of reclaiming and managing saline-alkali areas.

Field and laboratory methods

The samples used to obtain the data in table 11 were collected from carefully selected pits. The samples are

considered representative of the soil material that is made up of particles less than 3/4 inch in diameter. Estimates of the fraction of the sample consisting of particles larger than 3/4 inch were made during sampling. If necessary, the sample was sieved after it was dried and rock fragments larger than 3/4 inch in diameter were discarded. Then the material made up of particles less than 3/4 inch was rolled, crushed, and sieved by hand to remove rock fragments larger than 2 millimeters in diameter. The fraction that consisted of particles between 2 millimeters and 3/4 inch in diameter was recorded on the data sheets as the percentage greater than 2 millimeters.

Unless otherwise noted, all laboratory analyses were made on material that passed the 2-millimeter sieve and are reported on an ovendry basis. In table 11, values for extractable sodium and potassium are for amounts that have been extracted by the ammonium acetate method. These can be converted to exchangeable percentages by substracting the amounts that are soluble in the saturation extract.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data in table 11. Determinations of clay were made by the pipette method (*3*, *4*, *5*). The reaction of the saturated paste was measured with a

TABLE 10.—*Classification of soil series by higher categories*

Series	Classification			Great soil group (1938 classification)
	Family	Subgroup	Order	
Aberdeen	Fine, montmorillonitic	Glossic, Udic Natriborolls	Mollisols	Solonetz soils.
Arveson	Coarse-loamy, mixed, frigid	Typic Calciaquolls	Mollisols	Solonchak soils.
Arvilla	Coarse-loamy, mixed	Typic Haploborolls	Mollisols	Chernozems.
Barnes	Fine-loamy, mixed	Udic Haploborolls	Mollisols	Chernozems.
Bearden	Fine-silty, mixed, frigid	Aeric Calciaquolls	Mollisols	Solonchak soils.
Borup	Coarse-silty, mixed, frigid	Typic Calciaquolls	Mollisols	Solonchak soils.
Buse	Fine-loamy, mixed	Udorthentic Haploborolls	Mollisols	Regosols.
Cavour	Fine, mixed	Udic Natriborolls	Mollisols	Solonetz soils.
Claire	Mixed, frigid	Typic Ustipsamments	Entisols	Regosols.
Colvin	Fine-silty, mixed, frigid	Typic Calciaquolls	Mollisols	Solonchak soils.
Cresbard	Fine, mixed	Glossic Udic Natriborolls	Mollisols	Solonetz soils.
Divide	Fine-loamy over sandy or sandy-skeletal, mixed, frigid.	Aeric Calciaquolls	Mollisols	Solonchak soils.
Eckman	Coarse-silty, mixed	Udic Haploborolls	Mollisols	Chernozems.
Edgeley	Fine-loamy, mixed	Udic Haploborolls	Mollisols	Chernozems.
Egeland	Coarse-loamy, mixed	Udic Haploborolls	Mollisols	Chernozems.
Embden	Coarse-loamy, mixed	Pachic Udic Haploborolls	Mollisols	Chernozems.
Exline	Fine, mixed	Leptic Natriborolls	Mollisols	Solonetz soils.
Fargo	Montmorillonitic, frigid	Vertic Haplaquolls	Mollisols	Grumusols.
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed.	Pachic Udic Haploborolls	Mollisols	Chernozems.
Gardena	Coarse-silty, mixed	Pachic Udic Haploborolls	Mollisols	Chernozems.
Glyndon	Coarse-silty, mixed, frigid	Aeric Calciaquolls	Mollisols	Solonchak soils.
Grano	Fine, montmorillonitic, calcareous, frigid	Typic Haplaquolls	Mollisols	Humic Gley soils.
Great Bend	Fine-silty, mixed	Udic Haploborolls	Mollisols	Chernozems.
Hamar	Sandy, mixed, noncalcareous, frigid	Typic Haplaquolls	Mollisols	Humic Gley soils.
Hamerly	Fine-loamy, mixed, frigid	Aeric Calciaquolls	Mollisols	Solonchak soils.
Hecla	Sandy, mixed	Pachic Udic Haploborolls	Mollisols	Chernozems.
Hegne	Fine, montmorillonitic, frigid	Typic Calciaquolls	Mollisols	Solonchak soils.
LaDelle	Fine-silty, mixed	Cumulic Udic Haploborolls	Mollisols	Alluvial soils.
Lamoure	Fine-silty, mixed, calcareous, frigid	Cumulic Haplaquolls	Mollisols	Humic Gley soils.
LaPrairie	Fine-silty, mixed	Cumulic Udic Haploborolls	Mollisols	Alluvial soils.
Letcher	Coarse-loamy, mixed	Udic Natriborolls	Mollisols	Solonetz soils.
Ludden	Fine, montmorillonitic, calcareous, frigid	Vertic Haplaquolls	Mollisols	Humic Gley soils.
Maddock	Sandy, mixed	Udorthentic Haploborolls	Mollisols	Chernozems.
Nutley	Fine, montmorillonitic	Udertic Haploborolls	Mollisols	Chernozems.
Overly	Fine-silty, mixed	Pachic Udic Haploborolls	Mollisols	Chernozems.
Parnell	Fine, montmorillonitic, frigid	Typic Argiaquolls	Mollisols	Humic Gley soils.
Perella	Fine-silty, mixed, frigid	Typic Haplaquolls	Mollisols	Humic Gley soils.
Rauville	Fine, mixed, calcareous, frigid	Cumulic Haplaquolls	Mollisols	Humic Gley soils.
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed.	Udic Haploborolls	Mollisols	Chernozems.
Ryan	Fine, montmorillonitic, calcareous, frigid	Typic Natraquolls	Mollisols	Solonetz soils.
Sioux	Sandy-skeletal, mixed	Udorthentic Haploborolls	Mollisols	Regosols.
Spottswood	Fine-loamy over sandy or sandy-skeletal, mixed.	Pachic Udic Haploborolls	Mollisols	Chernozems.
Stirum	Coarse-loamy, mixed, calcareous, frigid	Typic Natraquolls	Mollisols	Solonetz soils.
Svea	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols	Chernozems.
Tiffany	Coarse-loamy, mixed, frigid	Typic Haplaquolls	Mollisols	Humic Gley soils.
Tonka	Fine, montmorillonitic, frigid	Argiaquic Argialbolls	Mollisols	Planosols.
Ulen	Coarse-loamy, mixed, frigid	Aeric Calciaquolls	Mollisols	Solonchak soils.
Vallers	Fine-loamy, mixed, frigid	Typic Calciaquolls	Mollisols	Solonchak soils.
Venlo	Sandy, mixed, frigid	Typic Haplaquolls	Mollisols	Humic Gley soils.

glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black method (*6*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of adsorbed ammonia (*6*). To determine the extractable calcium and magnesium, calcium was separated as calcium oxalate and magnesium as magnesium ammonium phosphate (*6*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*7*). Soluble sodium and potassium were determined on the saturation extract with a flame spectrophotometer.

General Nature of the Area

La Moure County, the largest part of the Survey Area, was organized in 1873. Stutsman County was organized in 1872 under the laws of Dakota Territory. The southern part of La Moure County was reorganized as Dickey County in 1881. A few pioneers settled along the James River Valley in the early eighties, but settlement was more rapid after railroad service was established. In 1890 the population of La Moure County was 3,187. It had increased to 10,724 by 1910 but had declined to 8,705 by 1960.

The larger towns have grain elevators and marketing facilities for milk, poultry, eggs, and other farm products. Railroad transportation is provided by five railway lines. There is a good network of all-weather roads throughout the Area. U.S. Highway No. 281 crosses La Moure County in a north-south direction.

Climate [8]

The climate of this Survey Area is typical of the Great Plains. The movement of weather systems across the Area brings frequent changes in weather in all seasons and wide variations in temperature from day to day and month to month. Summers are warm and pleasant, with sunny days and cool nights. Winters are cold. The sun shines about 60 percent of the daylight hours the year around. The percentage of sunshine ranges from about 45 percent of the daylight hours in winter to about 70 percent of the daylight hours in summer. More than 200 days a year are either clear or partly cloudy; the average cloud cover takes up about six-tenths of the sky. In summer the relative humidity ranges from about 80 percent early in the morning to about 45 percent late in the afternoon. In winter it averages 75 percent day and night.

Temperature and precipitation data, based on records at Edgeley, are given in table 12. The probability of the last low temperatures in spring and the first in fall are given in table 13. Except for minor differences caused by variations in local topography, these data are generally representative of the Survey Area.

The average annual precipitation is about 18 inches, but recorded amounts have ranged from less than 10 inches, in 1936, to more than 30 inches, in 1928. About 80 percent of the precipitation falls during the growing season, more than half of it in May, June, and July.

Precipitation amounting to 0.10 inch or more can be expected on an average of 38 days each year. Rainfall amounting to 1 inch or more in a single day can be expected about three times in a year. Figures 13 and 14 show the probability of receiving more or less than a given

[8] By ALFRED A. SKREDE, State climatologist, U.S. Weather Bureau.

TABLE 11.—*Physical and chemical*

[Analyses made at Soils Laboratory, North

Soil type	Horizon	Depth	Particle-size distribution: Very coarse to medium sand (2–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (<0.002 mm.)	Volume weight (clods)	Moisture held at— ⅓ atmosphere	15 atmospheres
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Gm./cc.*	*Pct.*	*Pct.*
Ludden silty clay.	Ap	0–5	1. 0	0. 8	3. 4	56. 7	37. 0	1. 34	39. 6	21. 3
	A1	5–13	. 7	. 7	2. 4	52. 8	42. 6	1. 65	38. 1	22. 3
	AC	13–24	. 8	. 9	2. 5	54. 7	41. 0	1. 70	40. 1	22. 1
	C1	24–32	. 5	1. 0	3. 1	54. 1	40. 9	1. 62	39. 3	20. 9
	C2	32–40	. 3	. 7	2. 5	53. 6	42. 3	1. 65	37. 8	20. 2
	C3	40–57	. 3	. 7	1. 9	54. 6	41. 7	1. 68	37. 9	20. 1
Ryan silty clay loam.	A2	0–2	. 3	. 2	1. 1	59. 7	36. 9	----------	----------	28. 6
	B21	2–4	. 8	. 8	. 8	49. 7	47. 4	----------	----------	29. 1
	B22	4–8	. 6	. 8	. 8	49. 3	47. 6	----------	----------	27. 7
	C1	8–22	1. 4	1. 4	1. 6	52. 5	42. 9	----------	----------	27. 8
	C2	22–36	2. 1	2. 2	2. 2	[1] 58. 8	[1] 34. 8	----------	----------	27. 7
	C3	36–48	1. 0	1. 6	1. 8	41. 4	54. 1	----------	----------	27. 5
	C4	48–60	. 8	1. 0	1. 4	37. 8	58. 9	----------	----------	25. 7

[1] Clay not dispersed.

amount of precipitation in a given period during the growing season. For example, figure 14 shows that the probability of receiving 1 inch or more of precipitation in the period May 31 to June 20 is about 83 percent.

Rainfall of the following intensities can be expected once in 2 years: 0.95 inch in 30 minutes, 1.2 inches in 1 hour, 1.35 inches in 2 hours, 1.5 inches in 3 hours, 1.7 inches in 6 hours, 2 inches in 12 hours, and 2.2 inches in 24 hours (*9*, *15*).

About 23 inches of snow can be expected in an average year, but the amount ranges from about 7 inches to more than 56 inches. Snow usually stays on the ground from early in December until the middle of March. A measurable amount of snow can be expected in October in 1 year out of 2, and in April in 3 years out of 5.

Pan evaporation data were obtained for the period 1951 to 1961 through the use of a Class A evaporation pan. These data show that for the growing season, April through September, precipitation averaged 14.49 inches and pan evaporation averaged 39.31 inches. Based on these figures and estimated by the Thornthwaite method (*11*), the potential evapotranspiration is 22.34 inches. The true potential is probably between 22.34 and 39.31, but closer to 39.31.

In June, July, and August, the maximum temperature averages 81°F. A temperature of 90° or more can be expected on 19 days in an average year. In winter the temperature averages about 12°, but it can be expected to exceed 32° on 27 days. The temperature falls below zero on an average of 49 days each year.

The average date of the last freezing temperature in spring is May 20, and the first in fall is September 17 (*8*). The average length of the freeze-free season is 121 days. Table 13 shows that there is a 25 percent probability of a temperature of 32° or lower after May 27, or once in 4 years. The data given in this table are based on readings from instruments housed in a shelter above ground level; frost can occur at ground level, even though the temperature in the shelter is above freezing.

In summer, most of the precipitation is in the form of thunderstorms. There are an average of 33 storms a year, usually in June and July. Hail accompanies two or three thunderstorms each year, but hail damage is relatively light. In the period 1941 to 1961, as much as 33 percent of the insured acreage in the Survey Area was damaged by hail, but the average was 9.7 percent. These data are based on records kept by the State Hail Insurance Department of North Dakota. They represent the percentage of insured acreage damaged more than 5 percent. According to weather records kept at Bismarck, about 33 percent of the days on which hail falls occur in June, 20 percent in July, 7 percent in September, and 5 percent in March, April, and October, combined.

The wind velocity is between 16 and 47 miles per hour about 34 percent of the time in April, 36 percent in May, and 26 percent in June. These are the months when fields have little protective cover. Throughout the year, but most frequently from October through April, winds are from the northwest about 12 percent of the time and from the northwest quadrant (west-northwest, northwest, and north-northwest) about 31 percent of the time. Winds are from the south about 8 percent of the time the year around, but most frequently in June, July, August, September, and December. The data on wind velocities are based on records at Jamestown, 40 miles north of Edgeley, for the years 1936 through 1938. The recording instruments were at a height of 32 feet above ground level.

Farming

Most of the Survey Area is farmland. In La Moure County, alone, about 98 percent of the acreage is farmed.

analyses of two soil profiles

Dakota Agricultural Experiment Station, Fargo]

Moisture at saturation	Reaction (saturated paste)	Organic carbon	C/N ratio	Electrical conductivity ($Ec \times 10^3$)	$CaCO_3$ equivalent	Cation-exchange capacity	Extractable cations				Sodium saturation (exchangeable sodium percentage)	Saturation extract soluble	
							Ca	Mg	Na	K		Na	K
Pct.	*pH*	*Pct.*		*Mmhos./cm. at 25° C.*	*Pct.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Pct.*	*Meq./liter*	*Meq./liter*
71	6. 3	3. 34	13	0. 5	--------	38. 1	21. 7	10. 9	0. 6	2. 0	1. 6	0. 8	0. 9
66	6. 1	1. 69	11	. 4	--------	41. 3	21. 1	14. 1	1. 2	. 9	2. 7	1. 3	. 2
70	6. 9	1. 27	10	. 7	<1	39. 2	20. 4	17. 4	2. 7	. 8	6. 0	5. 0	. 1
72	7. 6	. 91	10	1. 0	10	35. 6	46. 7	11. 5	3. 8	. 6	8. 9	8. 7	. 1
77	7. 7	. 81	10	2. 8	16	32. 4	51. 0	21. 0	5. 7	. 5	12. 0	22. 3	. 1
82	7. 9	. 64	10	4. 3	18	30. 7	38. 6	32. 2	7. 8	. 5	16. 2	38. 0	. 2
101	6. 1	6. 51	12	1. 8	--------	38. 2	17. 8	8. 8	3. 9	1. 9	7. 0	12. 3	. 6
102	7. 1	3. 43	11	2. 1	--------	44. 0	19. 4	14. 6	8. 1	1. 4	14. 3	18. 0	. 2
119	7. 9	3. 03	11	4. 3	<1	46. 6	19. 8	15. 3	13. 7	1. 1	19. 7	38. 1	. 2
94	8. 0	1. 91	10	22. 2	7	43. 5	36. 6	27. 6	28. 2	. 8	28. 5	168. 8	. 3
100	8. 0	1. 40	11	21. 5	7	41. 8	69. 2	22. 4	26. 1	. 8	30. 4	133. 6	. 3
126	8. 0	1. 27	10	21. 4	7	44. 7	51. 9	25. 8	26. 6	1. 0	24. 7	123. 2	. 3
133	7. 9	1. 11	12	20. 9	8	43. 2	40. 0	26. 2	24. 9	1. 0	24. 5	108. 2	. 3

In 1964 there were 1,093 farms, 439 of which were between 500 and 1,000 acres in size. An average farm covered 666 acres. Most farms are operated by their owners. The trend is toward fewer but larger farms.

The farms are mainly cash-grain, livestock, and general farms. Most of the irrigated farms are in Dickey County.

The principal field crops are spring wheat, oats, barley, rye, flax, corn, and alfalfa. Spring wheat has been the leading cash-grain crop since the Area was settled, but the acreage has decreased in recent years. Oats and barley are the most extensively grown feed grains. About 60 to 70 percent of the oats crop and about 25 to 40 percent of the barley crop is used for livestock feed, and the rest is sold. Corn ranks next to oats and barley as a feed crop. Rye is used mainly as a fall and winter cover crop and then is harvested the following summer as a cash-grain crop. Flax ranks next to wheat in importance as a cash crop.

Alfalfa and alfalfa-grass mixtures are the principal tame hay crops. Nearly all the crop is fed to sheep and cattle in fall and winter.

In 1964 wheat was harvested from 110,902 acres in La Moure County. Of this acreage, duram wheat was grown on 37,772 acres, other spring wheat was grown on 72,700 acres, and winter wheat was grown on the rest. Oats and

TABLE 12.—*Temperature and precipitation data*

[All data from Edgeley, La Moure County]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with— Maximum temperature equal to or higher than—	Two years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Days with snow cover	Average depth of snow on days with snow cover
	°F.	*°F.*	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	20	−2	41	−23	0. 37	0. 10	0. 70	22	3
February	24	2	46	−22	. 40	. 10	1. 00	19	4
March	37	16	59	−7	. 66	. 10	1. 30	9	2
April	56	29	76	16	1. 62	. 50	2. 90	2	2
May	68	40	86	26	2. 65	. 70	5. 00	[1]	0
June	76	50	90	39	3. 69	1. 50	6. 70	0	0
July	84	56	96	45	2. 67	1. 00	4. 40	0	0
August	83	53	95	42	2. 20	. 50	4. 20	0	0
September	72	44	91	29	1. 66	. 40	3. 60	[1]	0
October	59	33	80	16	1. 04	. 20	2. 50	1	0
November	40	18	61	−3	. 51	. 10	1. 40	5	1
December	25	5	65	−17	. 36	. 10	. 70	16	3
Year	54	29	[2] 102	[3] −32	17. 83	12. 00	23. 00	74	----------

[1] Less than half a day. [2] Average annual highest temperature. [3] Average annual lowest temperature.

TABLE 13.—*Probability of last low temperatures in spring and first in fall*

Probability	Dates for given probability and temperature				
	32° F. or lower	28° F. or lower	24° F. or lower	20° F. or lower	16° F. or lower
Spring:					
10 percent, later than	June 3	May 25	May 16	May 7	April 25
25 percent, later than	May 27	May 18	May 8	April 30	April 17
50 percent, later than	May 20	May 11	April 30	April 21	April 8
75 percent, later than	May 13	May 4	April 22	April 13	March 30
90 percent, later than	May 6	April 27	April 14	April 5	March 22
Fall:					
10 percent, earlier than	September 5	September 13	September 23	October 1	October 13
25 percent, earlier than	September 11	September 19	October 1	October 9	October 21
50 percent, earlier than	September 17	September 26	October 9	October 18	October 30
75 percent, earlier than	September 23	October 3	October 17	October 27	November 8
90 percent, earlier than	September 29	October 9	October 25	November 4	November 16

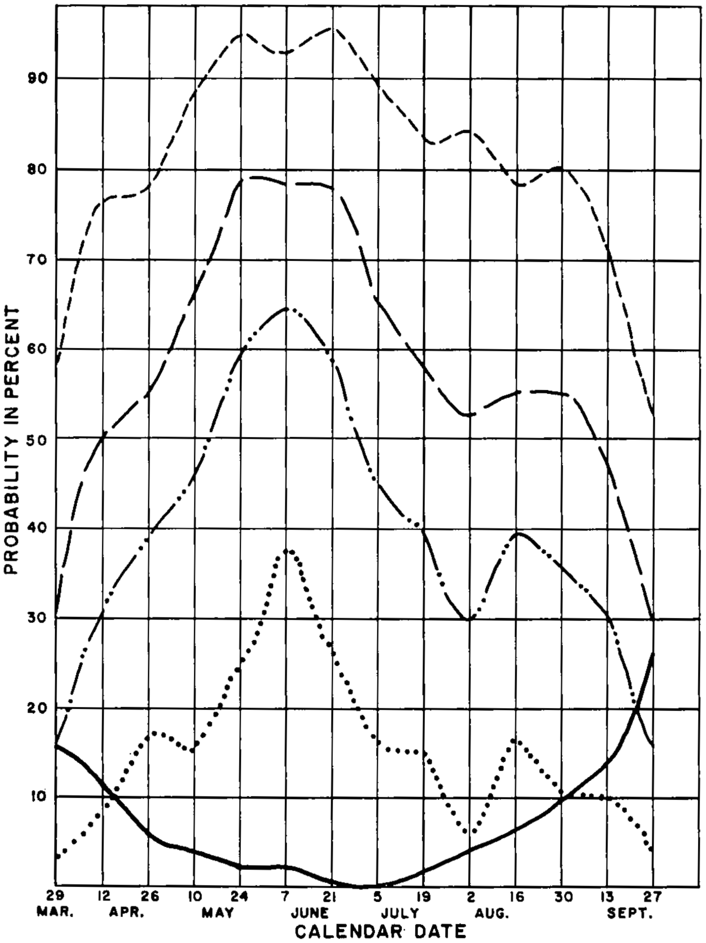

Figure 13.—**Probability of receiving indicated amounts of precipitation in a 2-week period. The unbroken line shows that precipitation amounts to a trace or less; the dashed line indicates precipitation of 0.20 inch or more; the broken line, 0.60 inch or more; the broken line with intermittent dots, 1 inch or more; and the dotted line, 2 inches or more.**

barley were harvested from 93,342 acres. Corn for all purposes was harvested from 34,553 acres, rye from 24,614 acres, and flaxseed from 56,205 acres. Alfalfa and alfalfa-grass mixtures were cut from 41,429 acres.

In addition to the field crops, small acreages of Irish potatoes and garden vegetables are grown for home consumption. There is also a small acreage of soybeans and millet.

The sale of livestock, livestock products, and poultry provides an important source of income to the farmers of this Area. In 1964 there were 64,183 cattle and calves on farms in La Moure County. There were 10,922 hogs and pigs and 13,119 sheep and lambs. Chickens more than 4 months old totaled 94,661, and turkeys numbered 108,185.

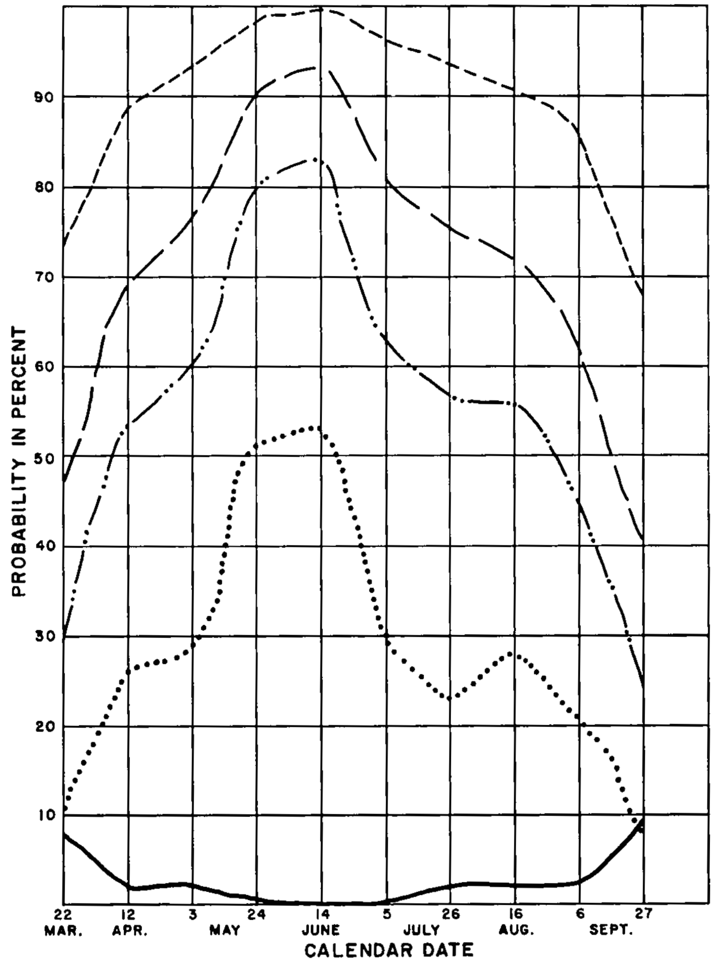

Figure 14.—**Probability of receiving indicated amounts of precipitation in a 3-week period. The key for this graph is the same as that in the legend for figure 13.**

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but that in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Buffer strips. Relatively narrow bands of tall-growing and annual crops or perennial vegetation grown specifically for erosion control. Corn is the main crop used for buffer strips for wind erosion control. Most buffers are used in conjunction with fallow where stripcropping or windbreaks are not used. Buffer strips are effective for erosion control, and they trap and spread snow over the field.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, and covered by grass for protection against erosion; used to conduct surface water away from cropland.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Lacustrine deposit (geology). Material deposited in lake water and exposed by lowering of the water level or elevation of the land.

Moisture-holding capacity. The capacity of a soil to hold water in a form available to plants. This is the amount of moisture held between field capacity (1/10 to 1/3 atmosphere) and the wilting coefficient (about 15 atmospheres of tension). In this survey, moisture-holding capacity is rated as follows for the root zone or top 4 feet of soil:

	Inches
High	More than 4.5
Moderate	3 to 4.5
Low	2 to 3
Very low	Less than 2

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common, and many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. The disintegrated and partly weathered rock from which soil has formed.

Permeability, soil. The quality of a soil that enables water or air to move through it. In this survey the terms used to describe permeability are as follows:

	Inches per hour in 3-inch core		*Inches per hour in 3-inch core*
Very slow	Less than 0.06	Moderate	0.63 to 2.00
Slow	0.06 to 0.20	Moderately rapid	2.00 to 6.30
Moderately slow	0.20 to 0.63	Rapid	6.30 to 20.00
		Very rapid	More than 20.00

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than .0 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Sodium adsorption ratio. A ratio expressing the relative activity of sodium in soil solutions.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter on earthy parent material, as conditioned by relief over periods of time.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Other information is given in tables as follows:

Acreage and extent, table 1, page 7.
Estimated average yields, table 5, page 76.
Windbreak sites, table 6, page 81.
Engineering uses of the soils, tables 7, 8, and 9, pages 86 through 111.

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Windbreak site
			Symbol	Page	Name	Page	Number
Ab	Aberdeen silt loam	9	IIIs-6P	72	Silty	79	8
Ae	Aberdeen-Exline complex	10	IIIs-6P	72	Saline Subirrigated	79	8
Af	Arveson fine sandy loam	10	IIIwe-3	71	Subirrigated	79	7
An	Arveson fine sandy loam, very poorly drained	10	Vw-WL	74	Wetlands	79	7
ArA	Arvilla sandy loam, level	11	IIIes-3	71	Sandy	79	5
ArB	Arvilla sandy loam, undulating	11	IIIes-3	71	Sandy	79	5
BaC	Barnes loam, rolling	12	IIIe-6	71	Silty	79	6
BaC2	Barnes loam, rolling, eroded	12	IIIe-6	71	Silty	79	6
BbC	Barnes-Buse loams, rolling	12	IIIe-6	71	Silty	79	6
BbD	Barnes-Buse loams, hilly	13	IVe-6	71	Silty	79	6
Bc	Barnes-Cresbard loams	13	IIc-6	68	Silty	79	2
Be	Barnes stony loam	12	VIs-Si	75	Silty	79	8
BgA	Barnes, Gardena, and Eckman loams, level	13	IIc-6	68	Silty	79	2
BhC	Barnes-Renshaw loams, rolling	13	IIIe-6	71	Silty	79	6
BnB	Barnes-Svea loams, undulating	13	---	--	---	--	--
	Barnes part	--	IIe-6	69	Silty	79	2
	Svea part	--	IIe-6	69	Silty	79	1
Bo	Bearden silt loam	14	IIe-4L	69	Silty	79	1
Br	Bearden silt loam, saline	14	IIIs-4	72	Saline Subirrigated	79	8
Bs	Bearden-Exline complex	14	IIIs-6P	72	Saline Subirrigated	79	8
Bt	Borup silt loam	15	IIw-4L	70	Subirrigated	79	8
Bu	Borup silt loam, very poorly drained	15	Vw-WL	74	Wetlands	79	8
BvE	Buse-Barnes loams, steep	16	VIe-Tsi	74	Thin Silty	80	8
Ca	Cavour complex	17	VIs-SS	75	Saline Subirrigated	79	8
Ce	Claire sandy loam	18	IIIes-3	71	Sandy	79	5
Ch	Colvin silty clay loam	18	IIw-4L	70	Subirrigated	79	8
Co	Colvin soils, saline	18	IIIws-4	73	Saline Subirrigated	79	8
Cs	Colvin soils, very poorly drained	19	Vw-WL	74	Wetlands	79	8
Cu	Cresbard, Barnes, and Cavour loams	19	IIIs-6P	72	Silty	79	8
Cv	Cresbard and Cavour loams	19	IIIs-6P	72	Silty	79	8
Dd	Divide loam	20	IIIs-4L	72	Silty	79	1
EaA	Eckman loam, level	21	IIc-6	68	Silty	79	2
EaB	Eckman loam, gently sloping	21	IIe-6	69	Silty	79	2
EaC	Eckman loam, sloping	21	IIIe-6	71	Silty	79	6
EbA	Edgeley loam, level	22	IIc-6	68	Silty	79	2
EbB	Edgeley loam, undulating	22	IIe-6	69	Silty	79	2
EcC	Egeland fine sandy loam, sloping	22	IIIe-3	70	Sandy	79	6
EdA	Egeland fine sandy loam, till substratum, level	22	IIIe-3	70	Sandy	79	2
EdB	Egeland fine sandy loam, till substratum, undulating	23	IIIe-3	70	Sandy	79	2
EeB	Egeland loam, till substratum, undulating	23	IIe-5	69	Silty	79	2
EgA	Egeland-Embden fine sandy loams, level	23	---	--	---	--	--
	Egeland part	--	IIIe-3	70	Sandy	79	2
	Embden part	--	IIIe-3	70	Sandy	79	1
EgB	Egeland-Embden fine sandy loams, undulating	23	---	--	---	--	--
	Egeland part	--	IIIe-3	70	Sandy	79	2
	Embden part	--	IIIe-3	70	Sandy	79	1
Em	Embden fine sandy loam	24	IIIe-3	70	Sandy	79	1
En	Embden fine sandy loam, silty substratum	24	IIIe-3	70	Sandy	79	1

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page	Windbreak site Number
Eo	Embden-Gardena loams, till substratum	24	IIe-5	69	Silty	79	1
Es	Exline silt loam	25	VIs-SS	75	Saline Subirrigated	79	8
Ex	Exline-Lamoure complex	25	VIs-SS	75	Saline Subirrigated	79	8
Fc	Fargo silty clay	26	IIwe-4	70	Clayey	80	1
Fh	Fargo and Hegne silty clays	26	IIwe-4	70	Clayey	80	1
FvA	Fordville loam, level	26	IIIs-5	72	Silty	79	5
FvB	Fordville loam, gently sloping	27	IIIes-5	71	Silty	79	5
Fw	Fresh water marsh	27	VIIIw-1	75	---	---	--
Ga	Gardena loam	28	IIc-6	68	Silty	79	1
GaB	Gardena loam, gently sloping	28	IIe-6	69	Silty	79	1
Gb	Gardena loam, silty substratum	28	IIc-6	68	Silty	79	1
Gc	Gardena loam, till substratum	29	IIc-6	68	Silty	79	1
GeA	Gardena and Eckman loams, level	29	---	--	---	--	--
	Gardena part	--	IIc-6	68	Silty	79	1
	Eckman part	--	IIc-6	68	Silty	79	2
Gl	Glyndon silt loam	29	IIe-4L	69	Silty	79	1
GlB	Glyndon silt loam, gently sloping	30	IIe-4L	69	Silty	79	1
Gm	Glyndon silt loam, saline	30	IIIs-4	72	Saline Subirrigated	79	8
Gn	Glyndon silt loam, silty substratum	30	IIe-4L	69	Silty	79	1
Go	Grano silty clay	30	Vw-WL	74	Wetlands	79	7
Gp	Gravel pits	30	---	--	---	--	--
GrB	Great Bend silty clay loam, gently sloping	31	IIe-6	69	Clayey	80	2
GtA	Great Bend-Barnes complex, level	31	IIc-6	68	Clayey	80	2
GtB	Great Bend-Barnes complex, undulating	31	IIe-6	69	Clayey	80	2
Ha	Hamar fine sandy loam	32	IIIwe-3	71	Subirrigated	79	7
He	Hamar loamy fine sand	32	IVe-2	73	Subirrigated	79	7
Hf	Hamerly loam	33	IIe-4L	69	Silty	79	1
Hg	Hamerly-Svea loams	33	IIe-4L	69	Silty	79	1
Hh	Hecla fine sandy loam	34	IIIe-3	70	Sandy	79	1
Hk	Hecla fine sandy loam, silty substratum	34	IIIe-3	70	Sandy	79	1
Hl	Hecla loamy fine sand	34	IVe-2	73	Sandy	79	1
HlB	Hecla loamy fine sand, gently undulating	34	IVe-2	73	Sandy	79	1
Hm	Hecla loamy fine sand, silty substratum	35	IVe-2	73	Sandy	79	1
Hn	Hecla-Hamar complex	35	---	--	---	--	--
	Hecla part	--	IIIe-3	70	Sandy	79	1
	Hamar part	--	IIIe-3	70	Sandy	79	7
HoA	Hecla-Hamar loamy fine sands, level	35	---	--	---	--	--
	Hecla part	--	IVe-2	73	Sandy	79	1
	Hamar part	--	IVe-2	73	Sandy	79	7
HoB	Hecla-Hamar loamy fine sands, gently undulating	36	---	--	---	--	--
	Hecla part	--	IVe-2	73	Sandy	79	1
	Hamar part	--	IVe-2	73	Sandy	79	7
HuA	Hecla-Ulen complex, level	36	---	--	---	--	--
	Hecla part	--	IVe-2	73	Sandy	79	1
	Ulen part	--	IVe-2	73	Sandy	79	7
HuB	Hecla-Ulen complex, gently undulating	36	IVe-2	73	Sandy	79	1
Hv	Hecla-Ulen fine sandy loams	36	IIIe-3	70	Sandy	79	1
Hx	Hegne-Fargo complex, sandy substrata	37	IIwe-4	70	Clayey	80	1
La	LaDelle silt loam	38	IIc-6	68	Silty	79	1
Lc	LaDelle silty clay loam	38	IIc-6	68	Clayey	80	1
Ld	LaDelle soils, clayey substratum	38	IIc-6	68	Silty	79	1
Le	Lamoure silty clay loam	39	IIw-4L	70	Subirrigated	79	8
Lf	Lamoure silty clay loam, saline	39	IIIws-4	73	Saline Subirrigated	79	8

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page	Windbreak site Number
Lg	LaPrairie silt loam	39	IIc-6	68	Silty	79	1
Ll	LaPrairie silt loam, channeled	39	IIe-6	68	Silty	79	1
Lm	LaPrairie and Lamoure soils, channeled	39	---	--	---	--	--
	LaPrairie part	--	VIe-Si	74	Silty	79	1
	Lamoure part	--	VIe-Si	74	Silty	79	8
Ln	Letcher fine sandy loam	40	IIIe-3P	71	Sandy	79	8
Lo	Loamy lake beaches	41	IVsw-6	74	Subirrigated	79	8
Lu	Ludden silty clay	41	IIwe-4	70	Clayey	80	1
Lw	Ludden silty clay, saline	41	IIIs-4	72	Saline Subirrigated	79	8
Ly	Ludden-Ryan silty clays	42	IIIs-4P	72	Saline Subirrigated	79	8
MaA	Maddock fine sandy loam, level	42	IIIe-3	70	Sandy	79	4
MaB	Maddock fine sandy loam, undulating	42	IIIe-3	70	Sandy	79	4
MbC	Maddock and Barnes soils, rolling	43	---	--	---	--	--
	Maddock part	--	IVe-3	73	Sandy	79	4
	Barnes part	--	IVe-3	73	Sandy	79	6
McB	Maddock and Hecla fine sands, undulating	43	---	--	---	--	--
	Maddock part	--	VIe-Sa	74	Sands	79	4
	Hecla part	--	VIe-Sa	74	Sands	79	1
MhB	Maddock and Hecla loamy fine sands, undulating	43	---	--	---	--	--
	Maddock part	--	IVe-2	73	Sandy	79	4
	Hecla part	--	IVe-2	73	Sandy	79	1
Mk3	Maddock and Hecla soils, severely eroded	43	---	--	---	--	--
	Maddock part	--	VIe-Sa	74	Sands	79	4
	Hecla part	--	VIe-Sa	74	Sands	79	1
MmB	Maddock-Hecla loamy fine sands, gently undulating	43	---	--	---	--	--
	Maddock part	--	IVe-2	73	Sandy	79	4
	Hecla part	--	IVe-2	73	Sandy	79	1
NuA	Nutley silty clay, level	44	IIe-4	69	Clayey	80	3
NuB	Nutley silty clay, gently sloping	45	IIe-4	69	Clayey	80	3
Ny	Nutley and Fargo silty clays	45	---	--	---	--	--
	Nutley part	--	IIe-4	69	Clayey	80	3
	Fargo part	--	IIe-4	69	Clayey	80	1
Oe	Overly silt loam	45	IIc-6	69	Silty	79	1
Or	Overly-Aberdeen complex	46	IIIs-6P	72	Silty	79	8
Pa	Parnell silty clay loam	46	---	--	---	--	--
	Drained areas	--	IIw-6	70	Wetlands	79	7
	Undrained areas	--	Vw-WL	74	Wetlands	79	7
Pm	Peat and muck, shallow	46	Vw-WL	74	Wetlands	79	8
Pr	Perella loam	47	---	--	---	--	--
	Drained areas	--	IIw-6	70	Wetlands	79	7
	Undrained areas	--	Vw-WL	74	Wetlands	79	7
Ra	Rauville soils	48	Vw-WL	74	Wetlands	79	8
RaC	Rauville soils, sloping	48	Vw-WL	74	Wetlands	79	8
ReA	Renshaw loam, level	49	IIIs-5	72	Silty	79	5
ReB	Renshaw loam, gently sloping	49	IIIes-5	71	Silty	79	5
RsA	Renshaw and Sioux soils, level	49	VIs-SwG	75	Shallow to Gravel	80	8
RsB	Renshaw and Sioux soils, gently sloping	49	VIs-SwG	75	Shallow to Gravel	80	8
Ru	Ryan silty clay	50	VIs-SS	75	Saline Subirrigated	79	8
Ry	Ryan-Ludden silty clays	50	VIs-SS	75	Saline Subirrigated	79	8
Sa	Saline land	50	VIs-SS	75	Saline Subirrigated	79	8

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page	Windbreak site Number
So	Sioux soils	51	VIs-SwG	75	Shallow to Gravel	80	8
Sp	Spottswood loam	51	IIIs-5	72	Silty	79	1
Sr	Stirum fine sandy loam	52	IIIws-3	73	Saline Sub-irrigated	79	8
Ss	Stirum fine sandy loam, very poorly drained	52	---	--	---	--	--
	Drained areas	--	IIIws-3	73	Wetlands	79	8
	Undrained areas	--	Vw-WL	74	Wetlands	79	8
St	Stirum-Exline complex	52	VIs-SS	75	Saline Sub-irrigated	79	8
Su	Stirum-Letcher fine sandy loams	53	IIIws-3	73	Saline Sub-irrigated	79	8
Sv	Svea loam	53	IIc-6	68	Silty	79	1
Sw	Svea-Barnes loams	53	---	--	---	--	--
	Svea part	--	IIc-6	68	Silty	79	1
	Barnes part	--	IIc-6	68	Silty	79	2
Tf	Tiffany fine sandy loam	54	IIIwe-3	71	Subirrigated	79	7
Tg	Tiffany fine sandy loam, silty substratum	55	IIIwe-3	71	Subirrigated	79	7
Tn	Tiffany loam	55	IIw-6	70	Subirrigated	79	7
To	Tonka soils	56	IIw-6	70	Overflow	79	7
Tp	Tonka and Parnell soils	56	IIw-6	70	Overflow	79	7
Ue	Ulen fine sandy loam	57	IIIe-3	70	Sandy	79	1
Uf	Ulen fine sandy loam, silty substratum	57	IIIe-3	70	Sandy	79	1
Uh	Ulen-Hamar complex	57	---	--	---	--	--
	Ulen part	--	IIIe-3	70	Sandy	79	1
	Hamar part	--	IIIe-3	70	Sandy	79	7
Va	Vallers silty clay loam	58	IIw-4L	70	Subirrigated	79	8
Ve	Venlo fine sandy loam	58	Vw-WL	74	Wetlands	79	7

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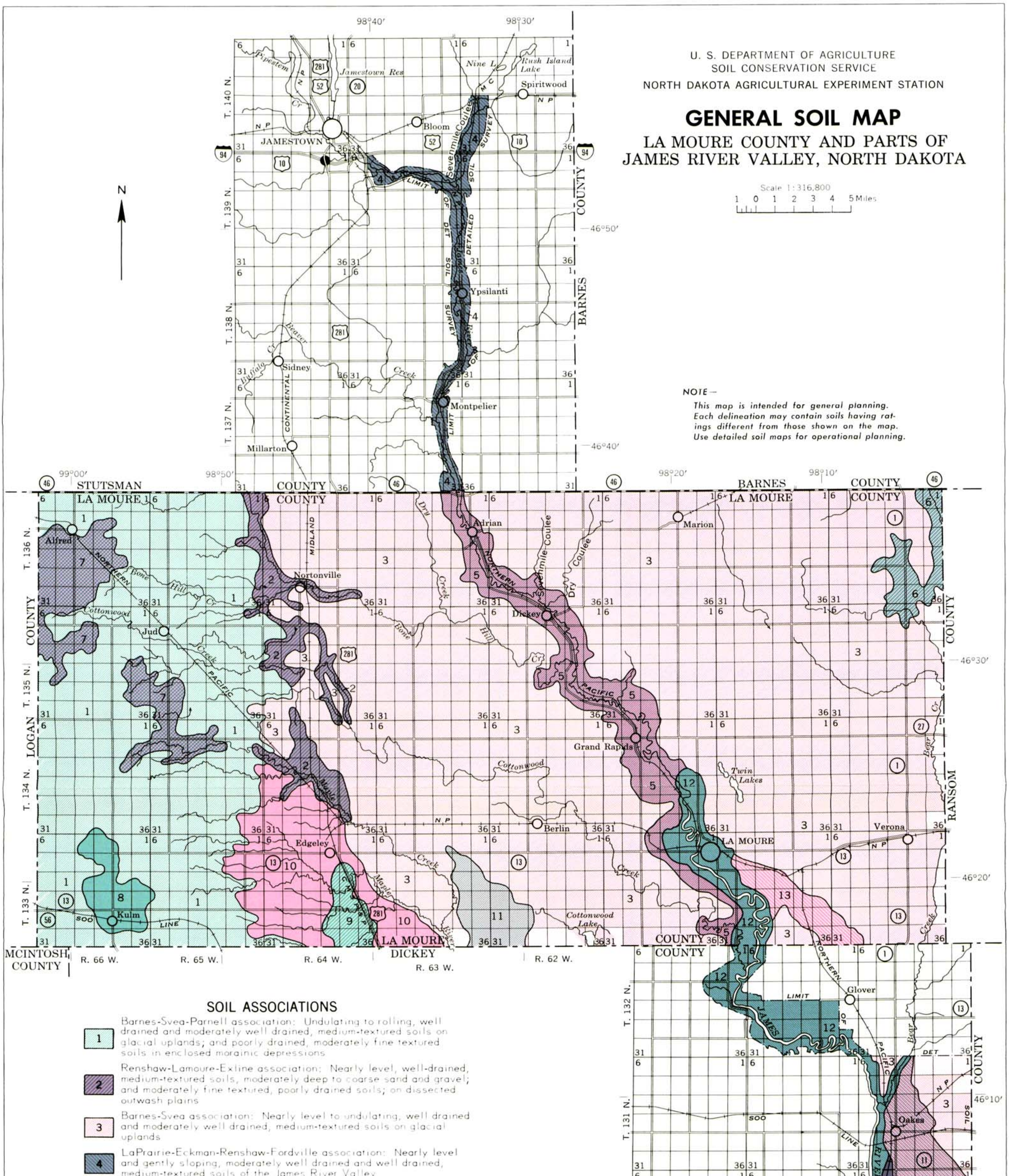
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA

Scale 1:316,800

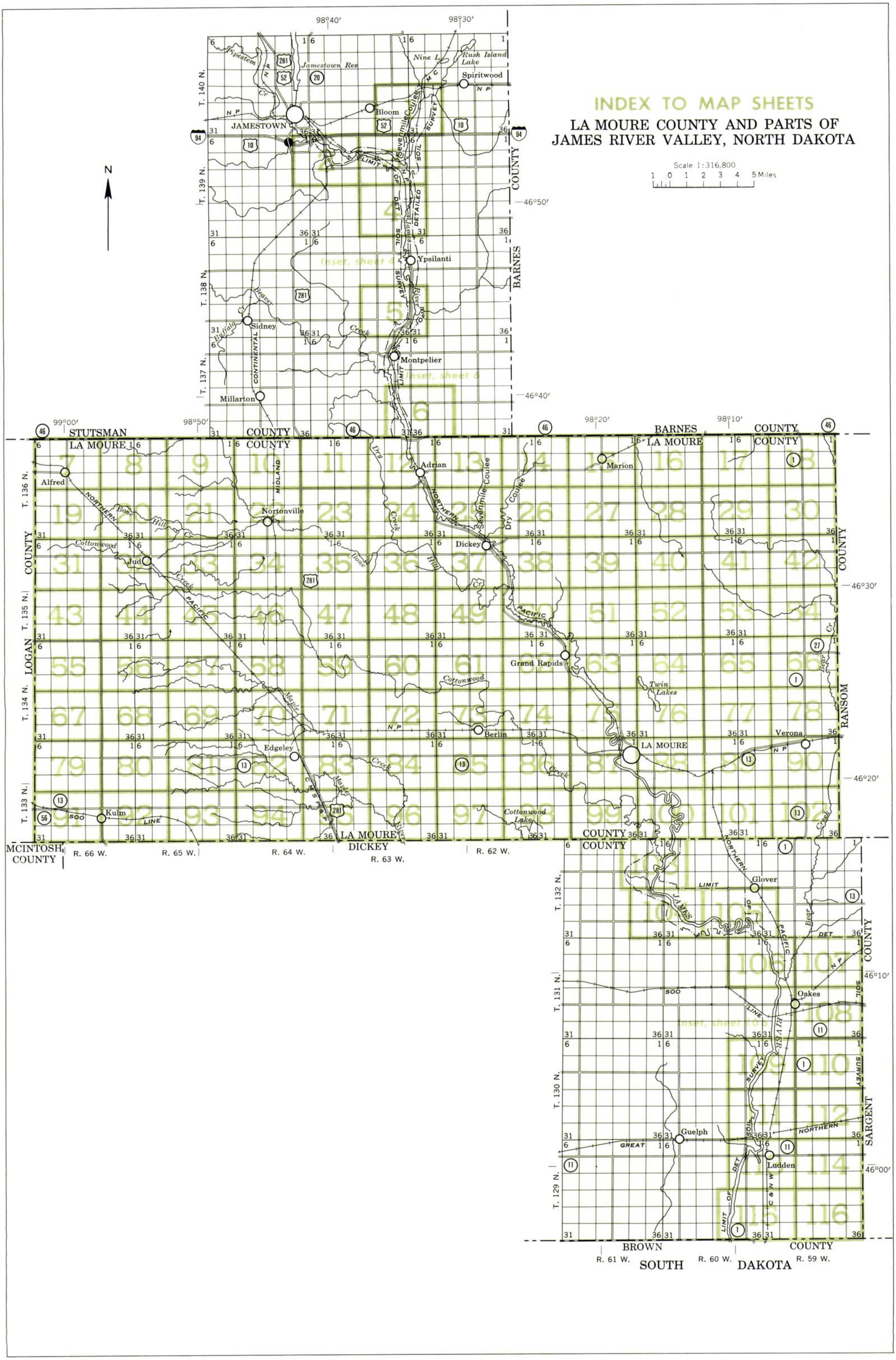
NOTE—
This map is intended for general planning. Each delineation may contain soils having ratings different from those shown on the map. Use detailed soil maps for operational planning.



SOIL ASSOCIATIONS

1	Barnes-Svea-Parnell association: Undulating to rolling, well drained and moderately well drained, medium-textured soils on glacial uplands; and poorly drained, moderately fine textured soils in enclosed morainic depressions
2	Renshaw-Lamoure-Exline association: Nearly level, well-drained, medium-textured soils, moderately deep to coarse sand and gravel; and moderately fine textured, poorly drained soils; on dissected outwash plains
3	Barnes-Svea association: Nearly level to undulating, well drained and moderately well drained, medium-textured soils on glacial uplands
4	LaPrairie-Eckman-Renshaw-Fordville association: Nearly level and gently sloping, moderately well drained and well drained, medium-textured soils of the James River Valley
5	Buse-Eckman-Renshaw-LaPrairie association: Steep to nearly level, excessively drained to moderately well drained, medium-textured soils of the James River Valley
6	Cresbard-Cavour association: Level, moderately well drained and somewhat poorly drained, medium-textured soils that are moderately deep and shallow to claypans; on glacial till plains
7	Buse-Barnes association: Steep to rolling, excessively drained to well-drained, medium-textured soils on morainic hills
8	Fargo-Nutley association: Nearly level to gently sloping, poorly drained to moderately well drained, fine-textured soils on old glacial lake plains
9	Edgeley association: Nearly level to undulating, moderately well drained and well drained soils formed in glacial till; moderately deep and deep to shale
10	Barnes-Cresbard association: Nearly level to undulating, medium-textured, well drained soils and level, moderately well drained and somewhat poorly drained soils that are moderately deep to a claypan; on glacial till plains
11	Embden-Gardena association: Nearly level, moderately well drained, moderately coarse textured and medium-textured soils on glacial till plains
12	LaDelle-Lamoure-Ludden-Ryan association: Nearly level, moderately well drained to poorly drained, medium-textured to fine-textured soils on bottom lands
13	Hecla-Maddock association: Nearly level to sloping, moderately well drained to somewhat excessively drained, moderately coarse textured and coarse textured soils on uplands and terraces
14	Hecla-Ulen association: Level to gently undulating, moderately well drained and somewhat poorly drained, moderately coarse textured soils on old glacial lake plains
15	Gardena-Glyndon-Overly association: Level, moderately well drained and somewhat poorly drained, medium-textured soils in old glacial lakebeds

February 1970



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JAMES RIVER VALLEY, NORTH DAKOTA
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Spiritwood
Bloom
Ypsilanti
Sidney
Montpelier
Millarton
Alfred
Adrian
Marion
Nortonville
Dickey
Jud
Grand Rapids
Berlin
Edgeley
LA MOURE
Verona
Kulm
Glover
Oakes
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T. 133 N.
T. 132 N.
T. 131 N.
T. 130 N.
T. 129 N.
98°40′
98°30′
99°00′
98°50′
98°20′
98°10′
46°50′
46°40′
46°30′
46°20′
46°10′
46°00′

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, or E, shows the slope. Most symbols without a slope letter are those of nearly level soils or land types, but some are for soils or land types that have a considerable range of slope. The number, 2 or 3, in a symbol shows that the soil is eroded or severely eroded.

SYMBOL	NAME
Ab	Aberdeen silt loam
Ae	Aberdeen–Exline complex
Af	Arveson fine sandy loam
An	Arveson fine sandy loam, very poorly drained
ArA	Arvilla sandy loam, level
ArB	Arvilla sandy loam, undulating
BaC	Barnes loam, rolling
BaC2	Barnes loam, rolling, eroded
BbC	Barnes–Buse loams, rolling
BbD	Barnes–Buse loams, hilly
Bc	Barnes–Cresbard loams
Be	Barnes stony loam
BgA	Barnes, Gardena, and Eckman loams, level
BhC	Barnes–Renshaw loams, rolling
BnB	Barnes–Svea loams, undulating
Bo	Bearden silt loam
Br	Bearden silt loam, saline
Bs	Bearden–Exline complex
Bt	Borup silt loam
Bu	Borup silt loam, very poorly drained
BvE	Buse–Barnes loams, steep
Ca	Cavour complex
Ce	Claire sandy loam
Ch	Colvin silty clay loam
Co	Colvin soils, saline
Cs	Colvin soils, very poorly drained
Cu	Cresbard, Barnes, and Cavour loams
Cv	Cresbard and Cavour loams
Dd	Divide loam
EaA	Eckman loam, level
EaB	Eckman loam, gently sloping
EaC	Eckman loam, sloping
EbA	Edgeley loam, level
EbB	Edgeley loam, undulating
EcC	Egeland fine sandy loam, sloping
EdA	Egeland fine sandy loam, till substratum, level
EdB	Egeland fine sandy loam, till substratum, undulating
EeB	Egeland loam, till substratum, undulating
EgA	Egeland–Embden fine sandy loams, level
EgB	Egeland–Embden fine sandy loams, undulating
Em	Embden fine sandy loam
En	Embden fine sandy loam, silty substratum
Eo	Embden–Gardena loams, till substratum
Es	Exline silt loam
Ex	Exline–Lamoure complex
Fc	Fargo silty clay
Fh	Fargo and Hegne silty clays
FvA	Fordville loam, level
FvB	Fordville loam, gently sloping
Fw	Fresh water marsh
Ga	Gardena loam
GaB	Gardena loam, gently sloping
Gb	Gardena loam, silty substratum
Gc	Gardena loam, till substratum
GeA	Gardena and Eckman loams, level
Gl	Glyndon silt loam
GlB	Glyndon silt loam, gently sloping
Gm	Glyndon silt loam, saline
Gn	Glyndon silt loam, silty substratum
Go	Grano silty clay
Gp	Gravel pits
GrB	Great Bend silty clay loam, gently sloping
GtA	Great Bend–Barnes complex, level
GtB	Great Bend–Barnes complex, undulating
Ha	Hamar fine sandy loam
He	Hamar loamy fine sand
Hf	Hamerly loam
Hg	Hamerly–Svea loams
Hh	Hecla fine sandy loam
Hk	Hecla fine sandy loam, silty substratum
Hl	Hecla loamy fine sand
HlB	Hecla loamy fine sand, gently undulating
Hm	Hecla loamy fine sand, silty substratum
Hn	Hecla–Hamar complex
HoA	Hecla–Hamar loamy fine sands, level
HoB	Hecla–Hamar loamy fine sands, gently undulating
HuA	Hecla–Ulen complex, level
HuB	Hecla–Ulen complex, gently undulating
Hv	Hecla–Ulen fine sandy loams
Hx	Hegne–Fargo complex, sandy substrata
La	LaDelle silt loam
Lc	LaDelle silty clay loam
Ld	LaDelle soils, clayey substratum
Le	Lamoure silty clay loam
Lf	Lamoure silty clay loam, saline
Lg	LaPrairie silt loam
Ll	LaPrairie silt loam, channeled
Lm	LaPrairie and Lamoure soils, channeled
Ln	Letcher fine sandy loam
Lo	Loamy lake beaches
Lu	Ludden silty clay
Lw	Ludden silty clay, saline
Ly	Ludden–Ryan silty clays
MaA	Maddock fine sandy loam, level
MaB	Maddock fine sandy loam, undulating
MbC	Maddock and Barnes soils, rolling
McB	Maddock and Hecla fine sands, undulating
MhB	Maddock and Hecla loamy fine sands, undulating
Mk3	Maddock and Hecla soils, severely eroded
MmB	Maddock–Hecla loamy fine sands, gently undulating
NuA	Nutley silty clay, level
NuB	Nutley silty clay, gently sloping
Ny	Nutley and Fargo silty clays
Oe	Overly silt loam
Or	Overly–Aberdeen complex
Pa	Parnell silty clay loam
Pm	Peat and muck, shallow
Pr	Perella loam
Ra	Rauville soils
RaC	Rauville soils, sloping
ReA	Renshaw loam, level
ReB	Renshaw loam, gently sloping
RsA	Renshaw and Sioux soils, level
RsB	Renshaw and Sioux soils, gently sloping
Ru	Ryan silty clay
Ry	Ryan–Ludden silty clays
Sa	Saline land
So	Sioux soils
Sp	Spottswood loam
Sr	Stirum fine sandy loam
Ss	Stirum fine sandy loam, very poorly drained
St	Stirum–Exline complex
Su	Stirum–Letcher fine sandy loams
Sv	Svea loam
Sw	Svea–Barnes loams
Tf	Tiffany fine sandy loam
Tg	Tiffany fine sandy loam, silty substratum
Tn	Tiffany loam
To	Tonka soils
Tp	Tonka and Parnell soils
Ue	Ulen fine sandy loam
Uf	Ulen fine sandy loam, silty substratum
Uh	Ulen–Hamar complex
Va	Vallers silty clay loam
Ve	Venlo fine sandy loam

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry — FY
- Ford — FORD
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

BOUNDARIES

- National or state
- County
- Area boundary
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Unclassified

Canals and ditches — CANAL

Lakes and ponds
- Perennial — water, w
- Intermittent — int

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

Wells, water — flowing

RELIEF

Escarpments
- Bedrock
- Other

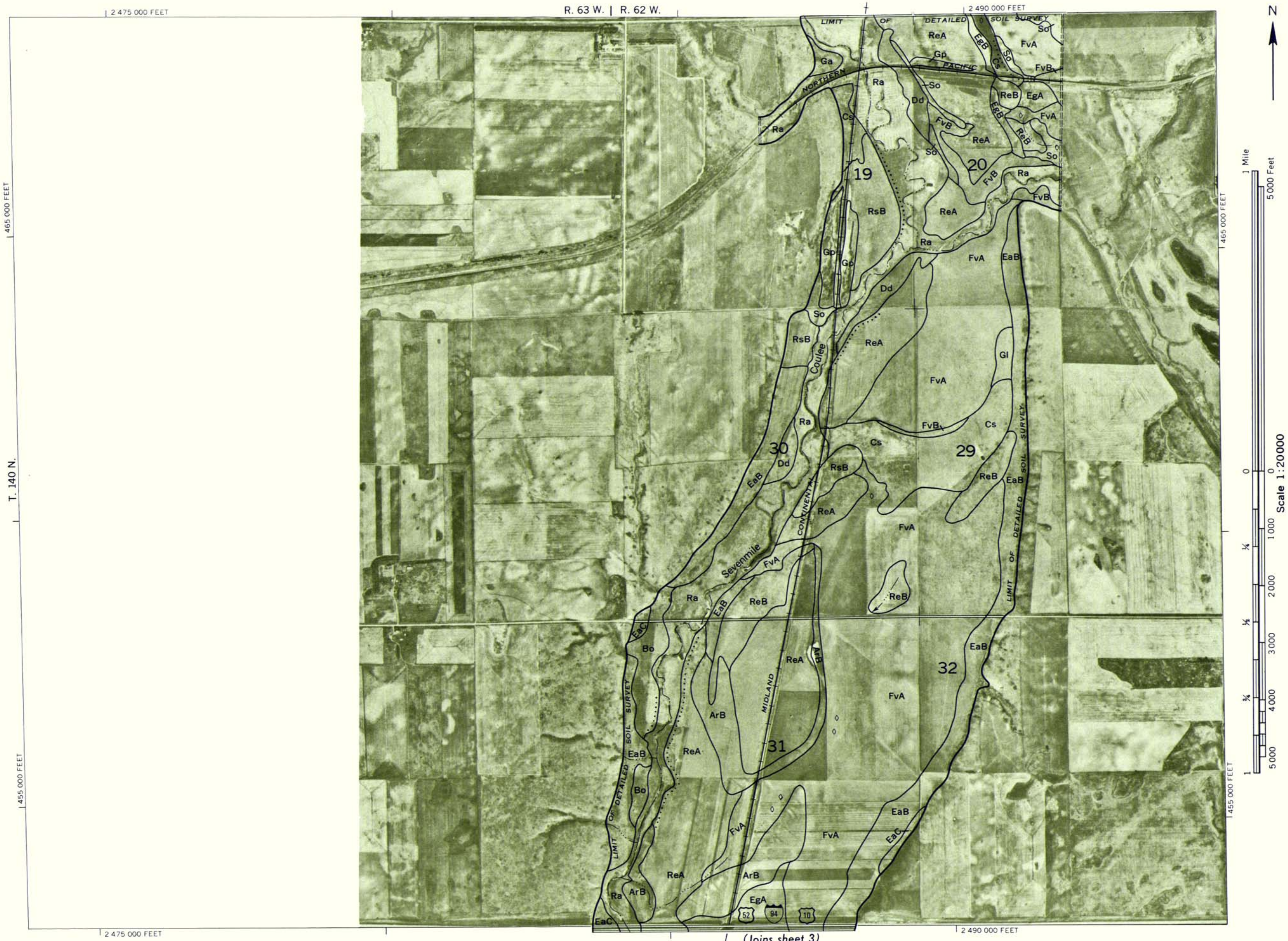
Prominent peak

Depression, unclassified — Large, Small

SOIL SURVEY DATA

- Soil boundary and symbol — Dx
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Overblown soil
- Line drift
- Short steep slope
- Saline spot

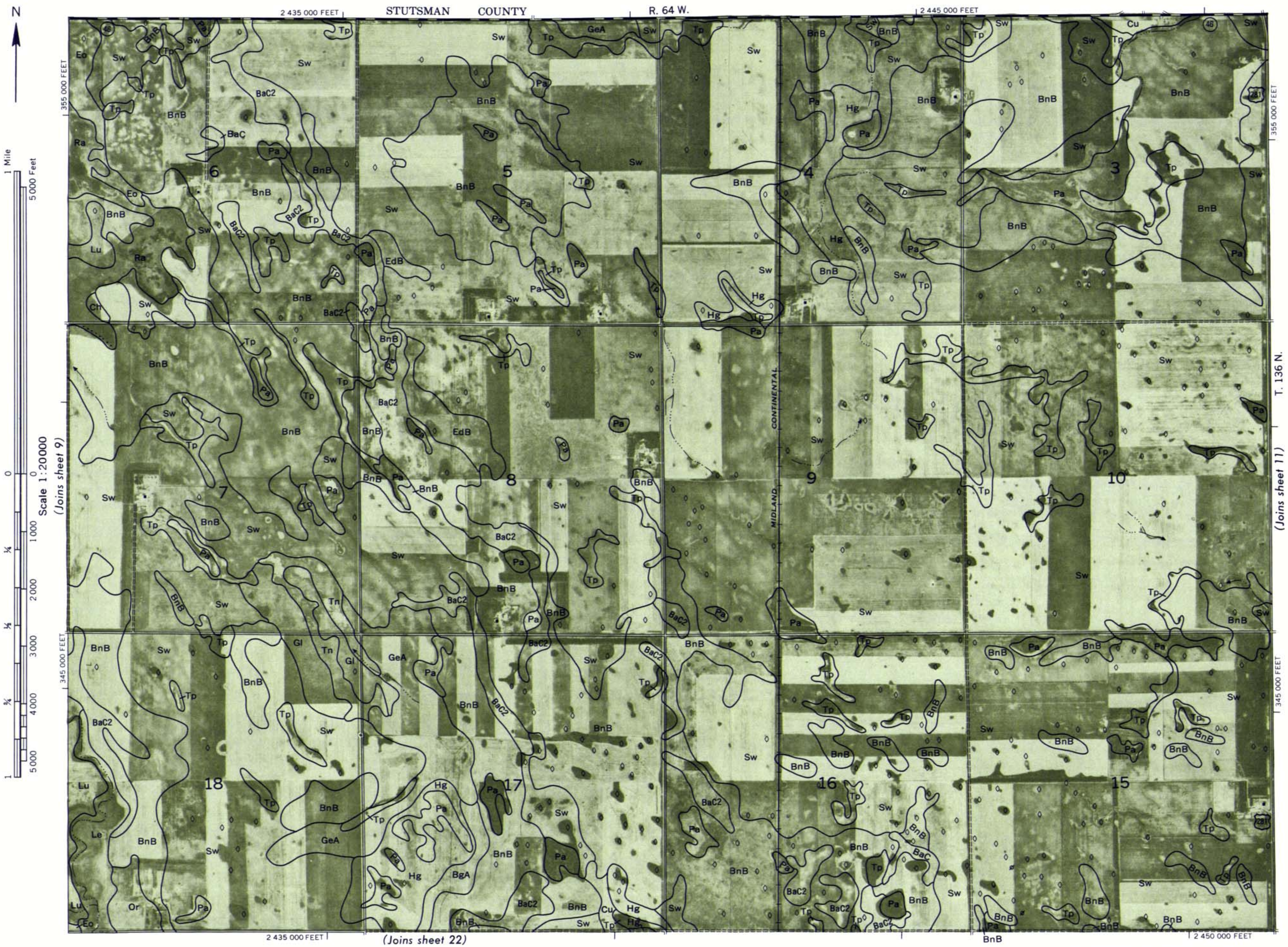
Soil map constructed 1968 by Cartographic Division, Soil Conservation Service, USDA, from 1964 aerial photographs. Controlled mosaic based on North Dakota plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 1

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 10



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 10

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 100

Plane coordinate system. 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 100

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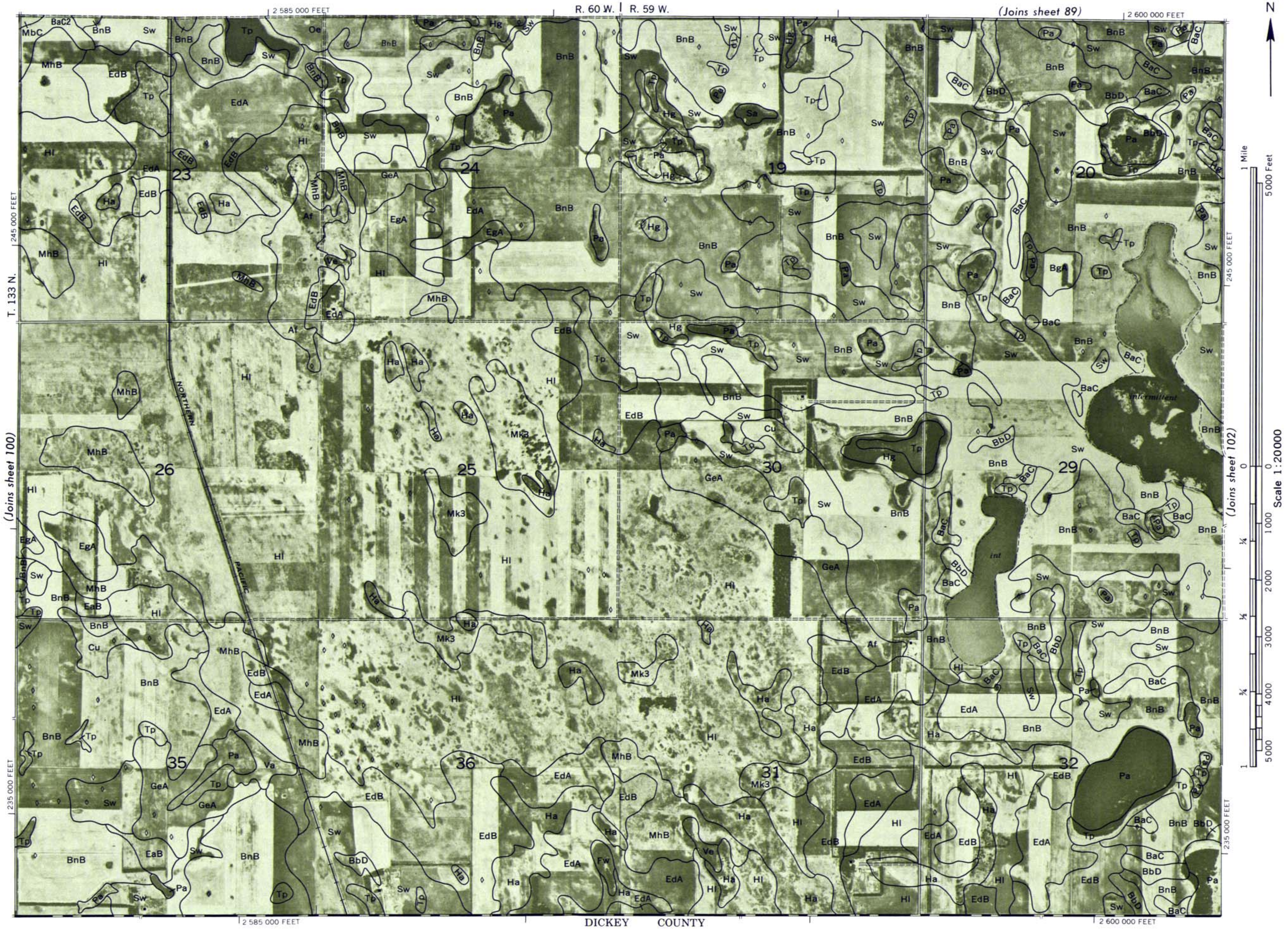
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 101



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 102

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 102

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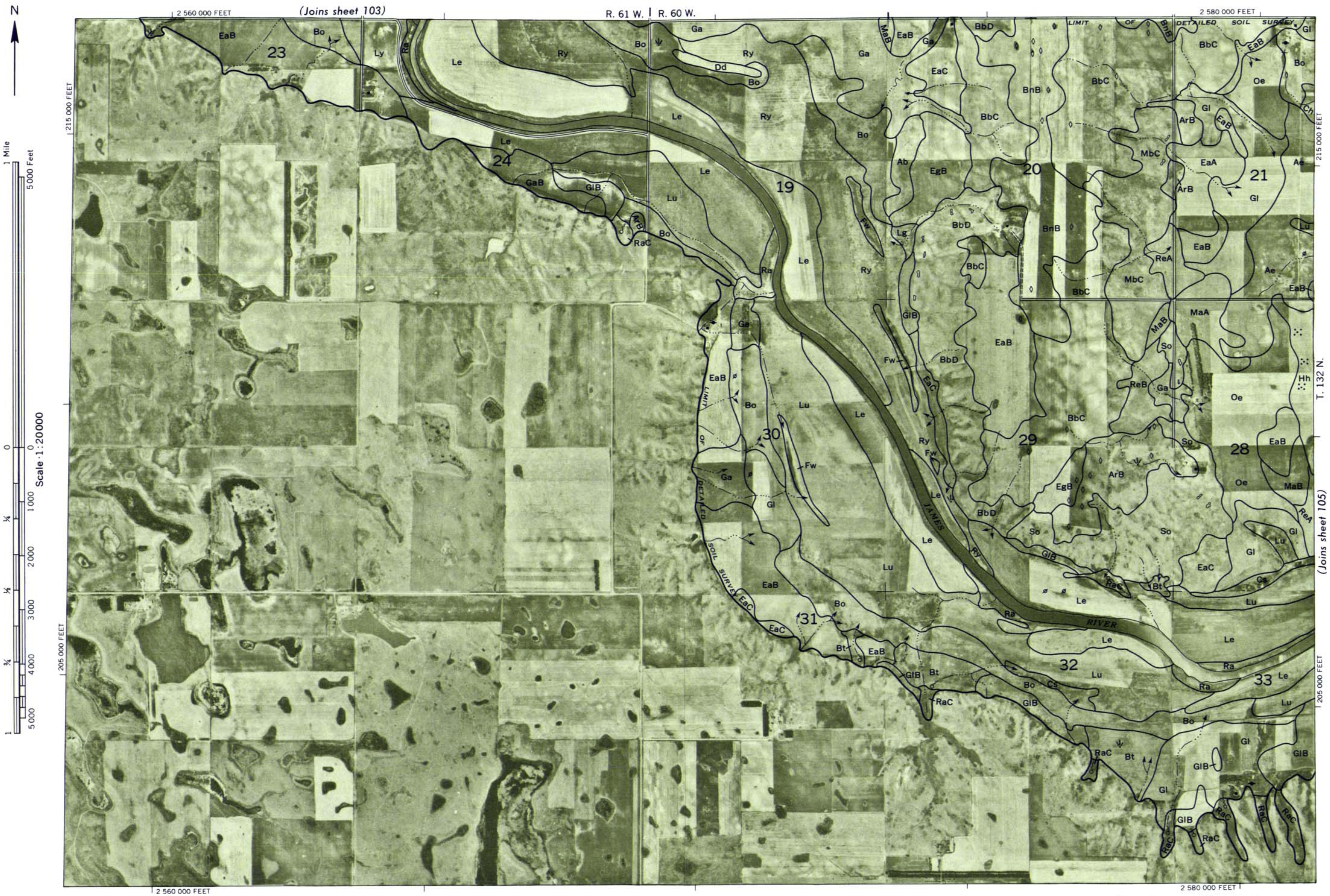
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 103

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 104



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 104

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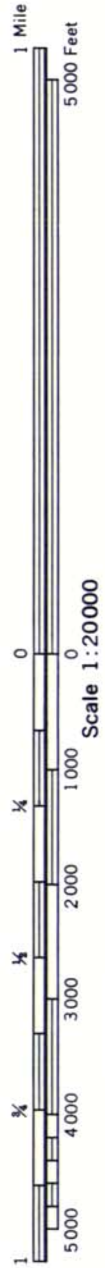
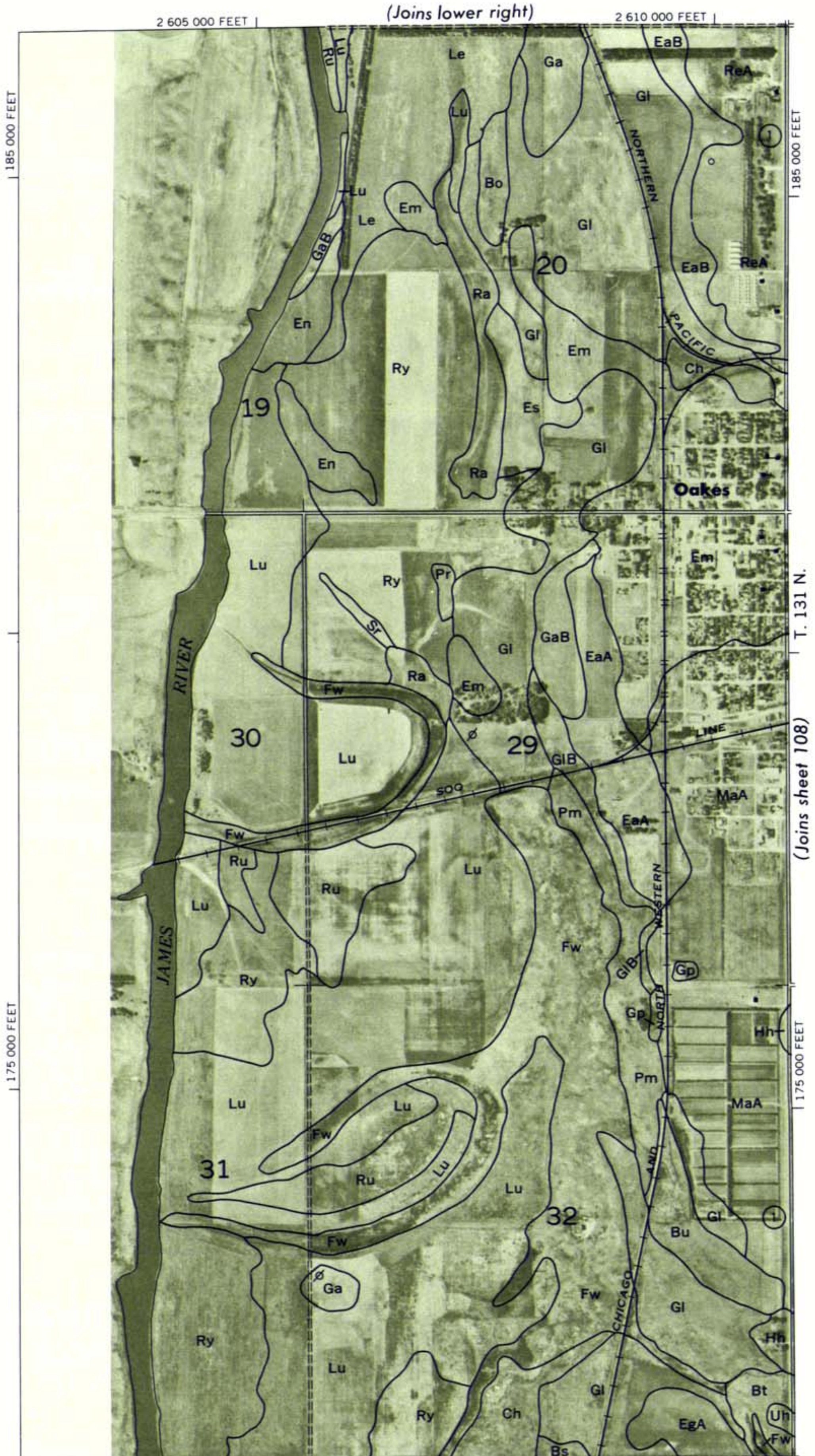
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 105

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 106

N





Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 106

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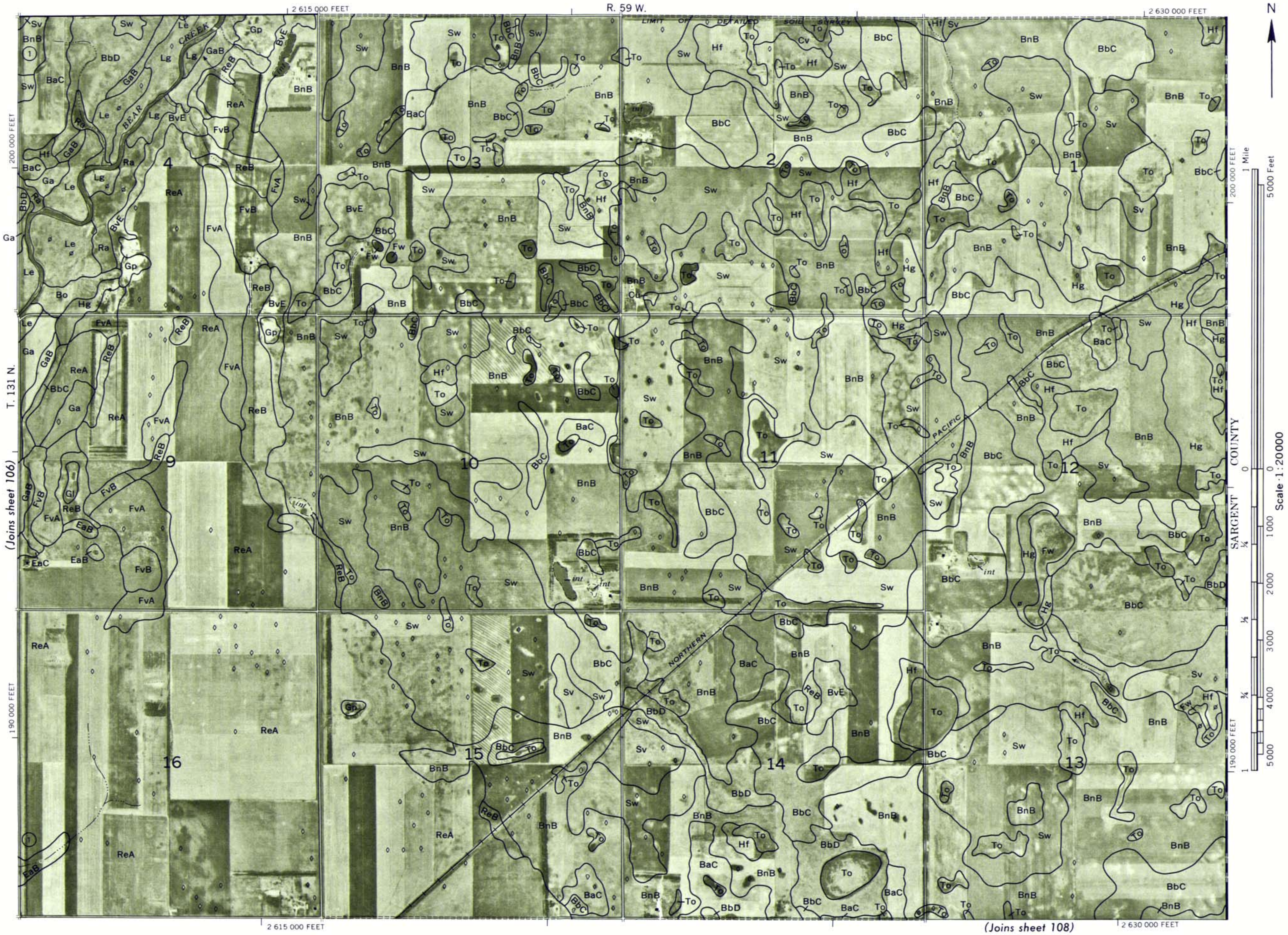
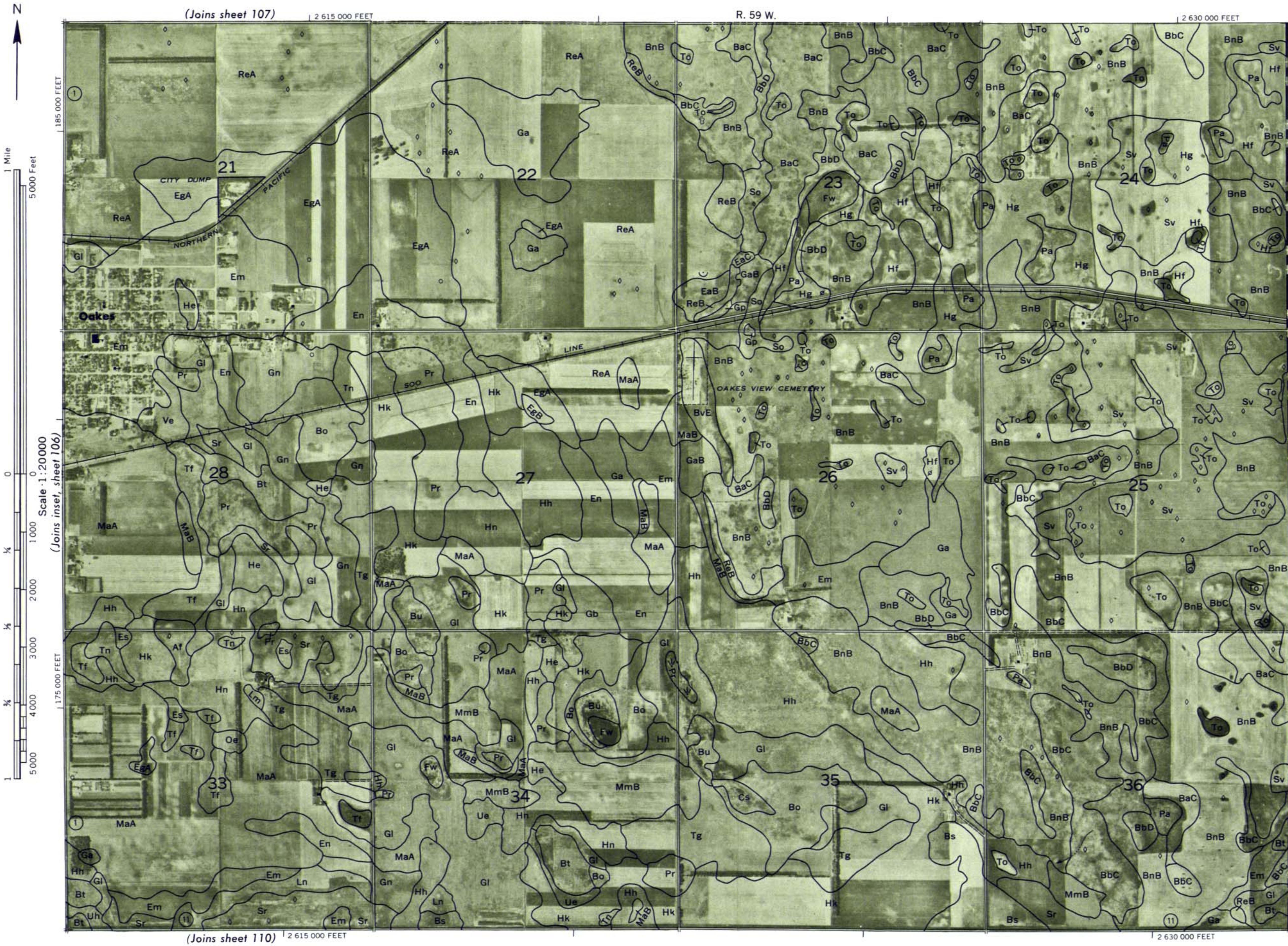
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 107



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 108



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 108

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5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

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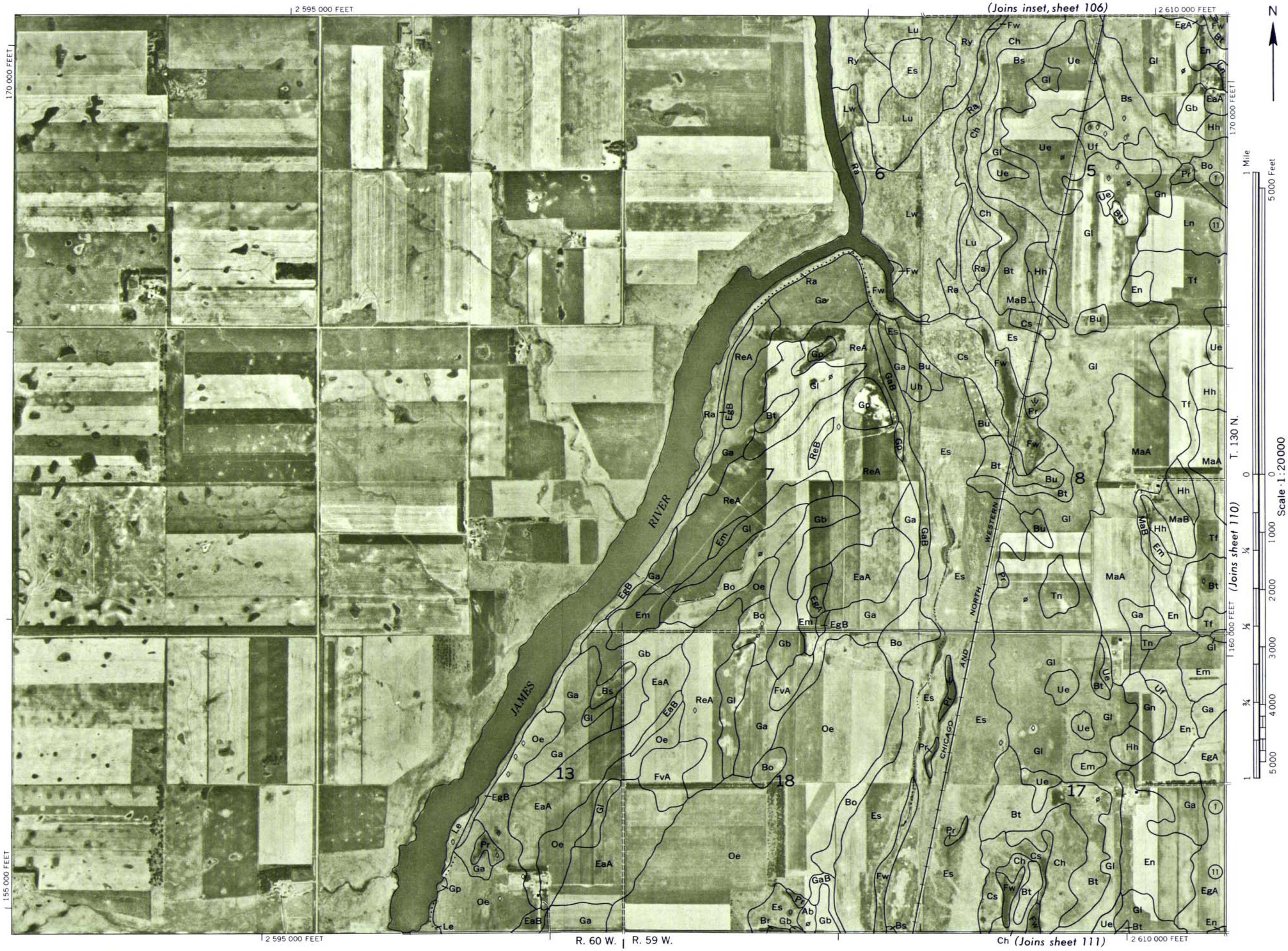
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 109



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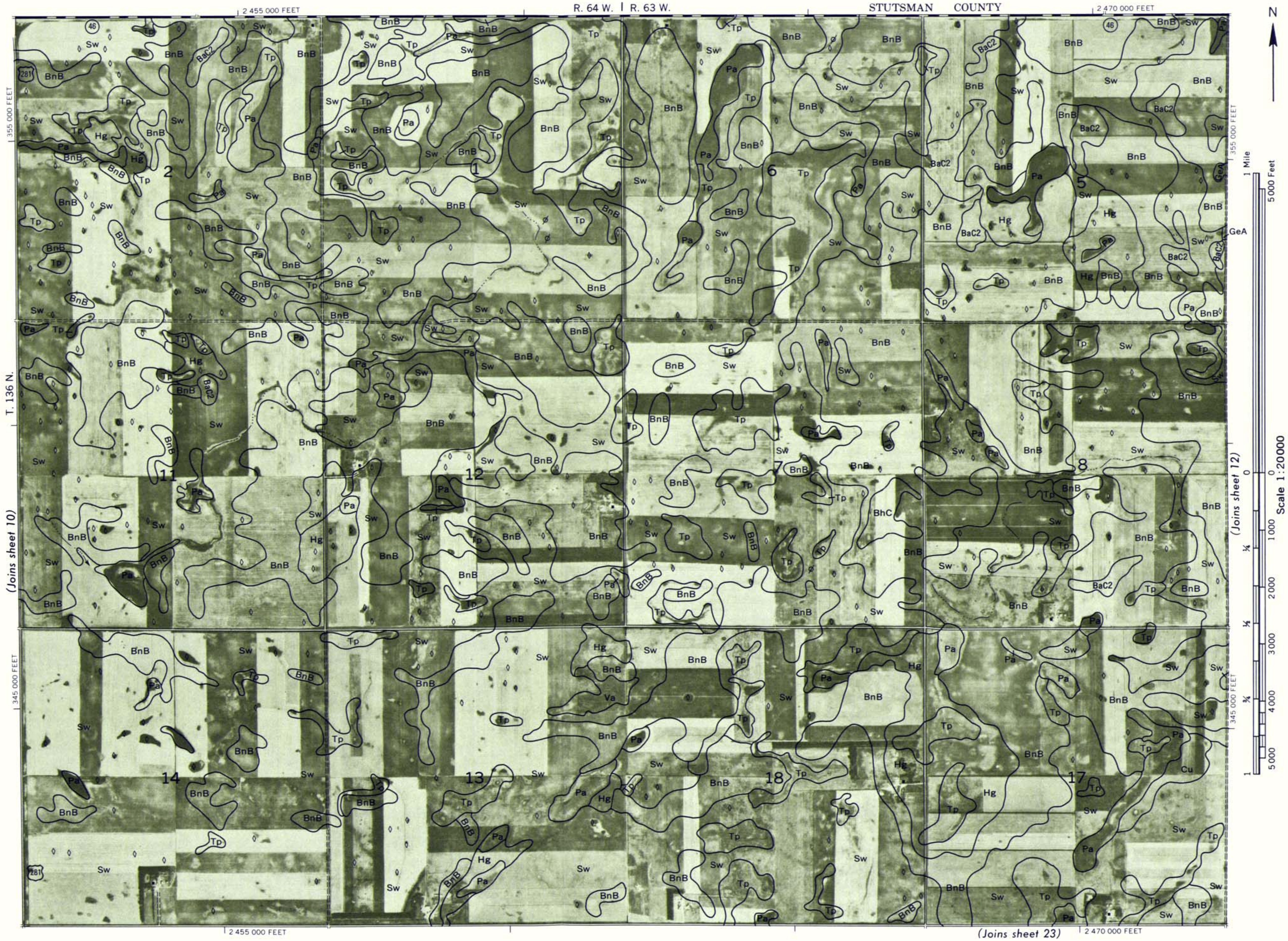
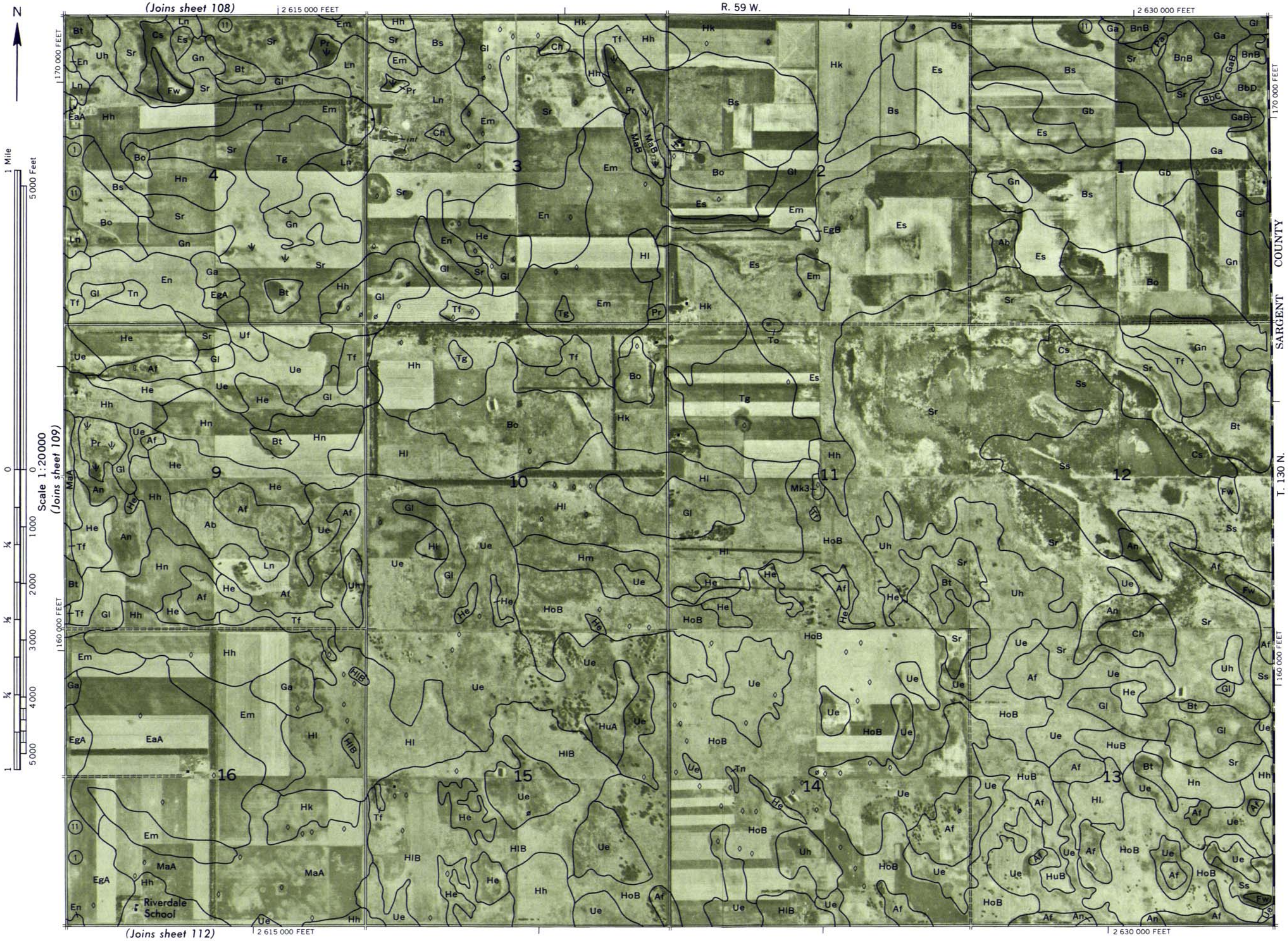
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 11



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 110



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 110

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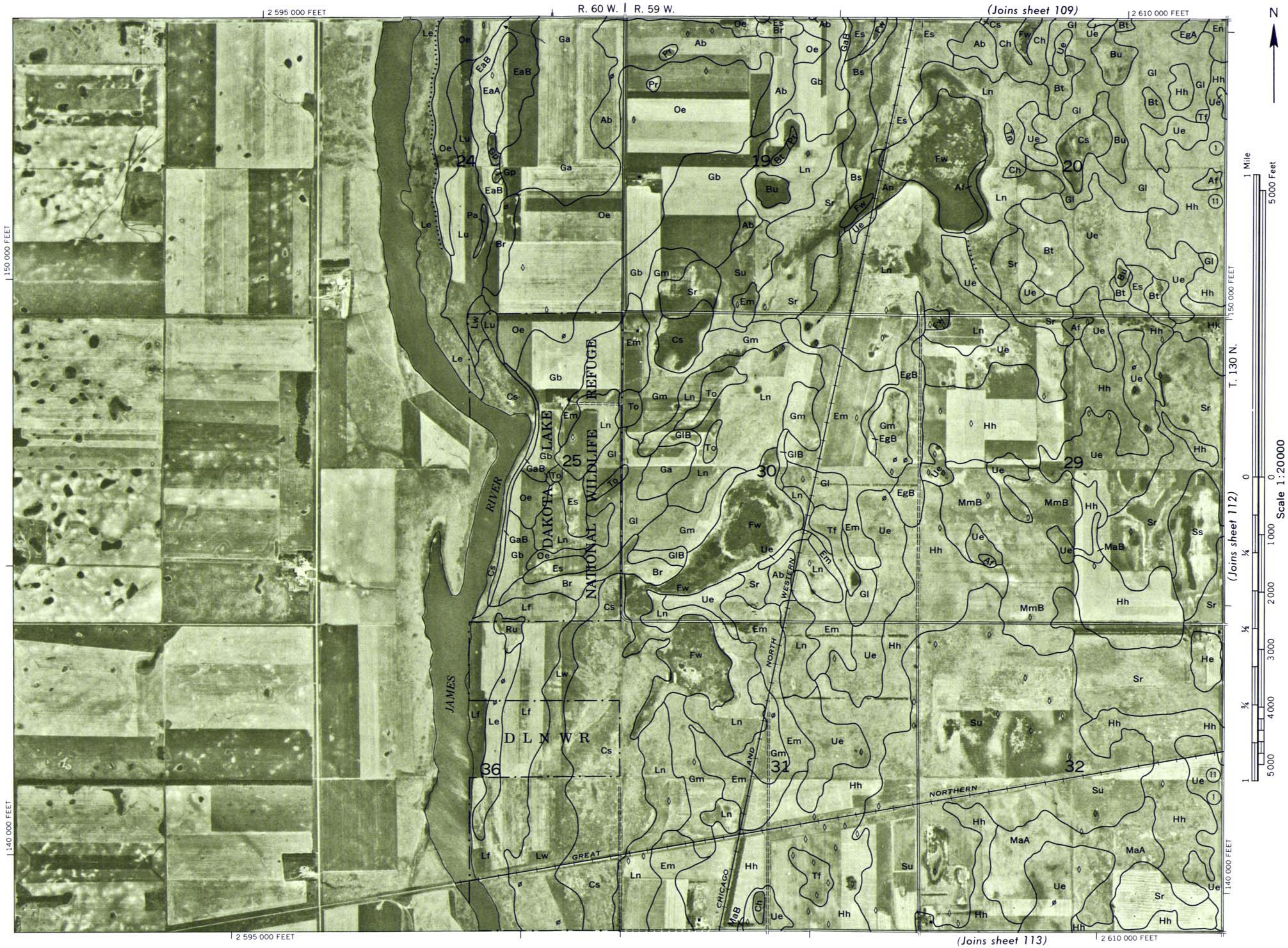

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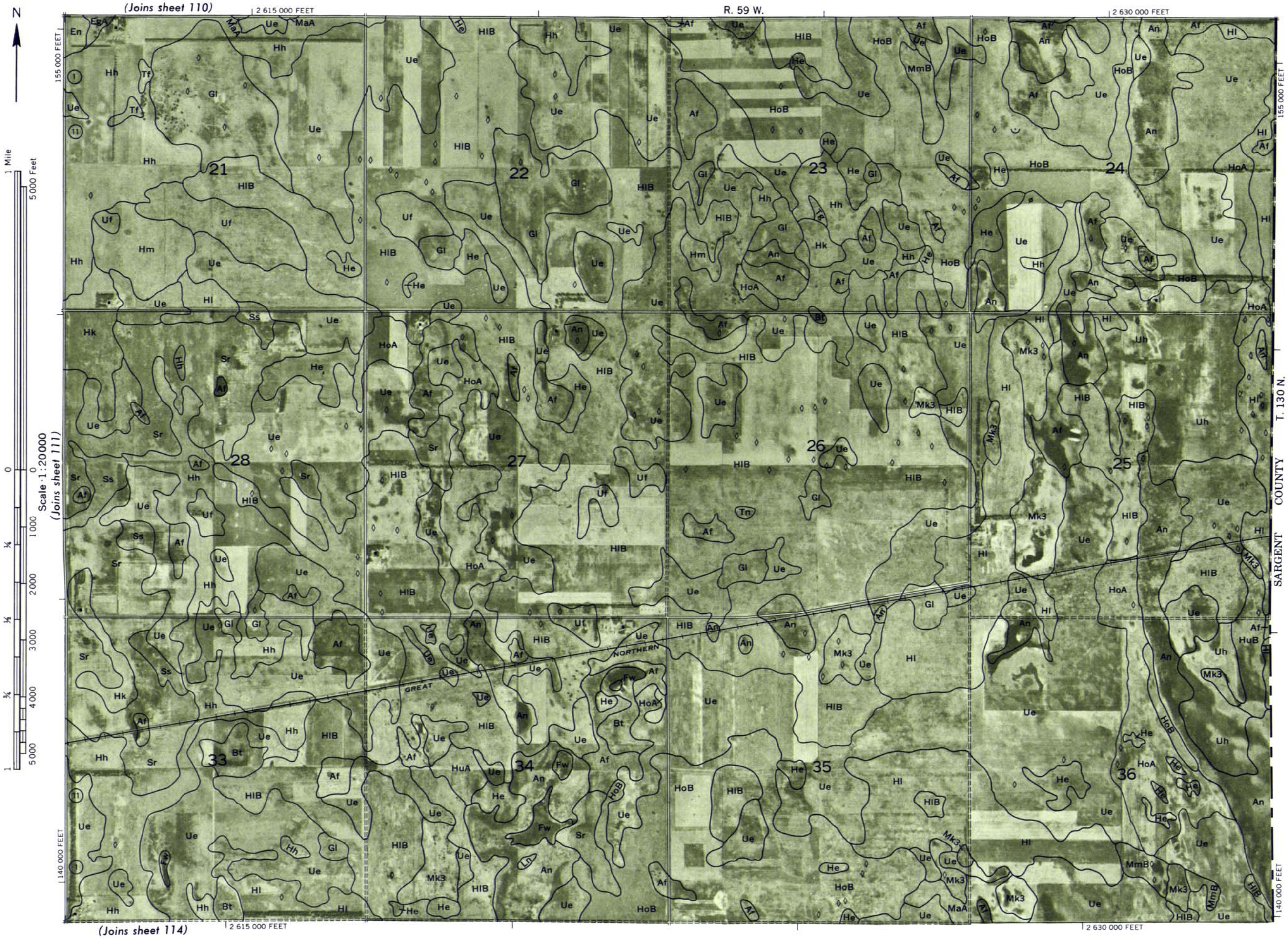
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 111



Plane coordinate system, 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 112

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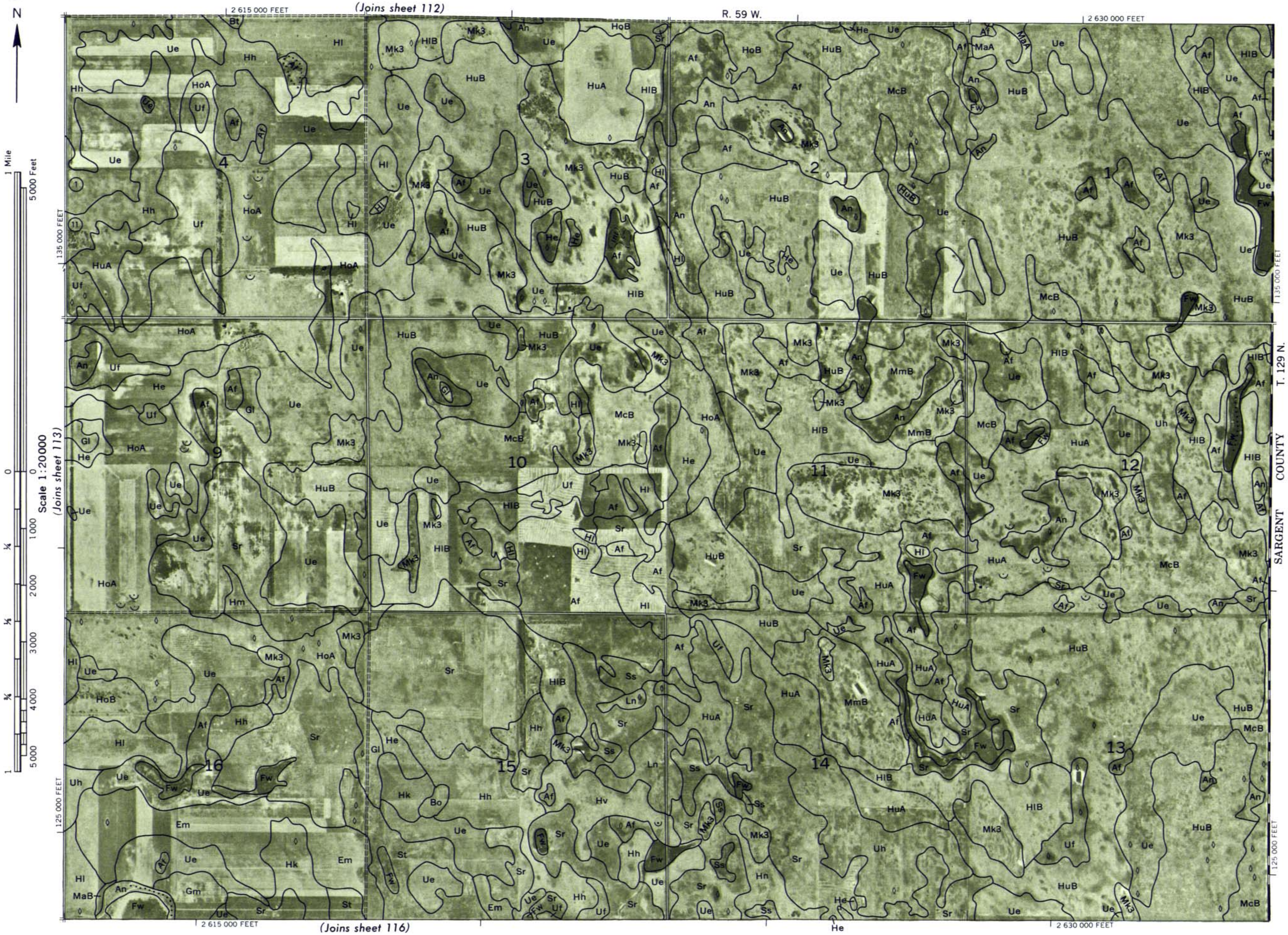
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 113

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 114

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

115

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 115

2 590 000 FEET

R. 60 W. | R. 59 W.

(Joins sheet 113)

2 610 000 FEET

N

120 000 FEET

T. 129 N.

110 000 FEET

(Joins sheet 116)

120 000 FEET

110 000 FEET

1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

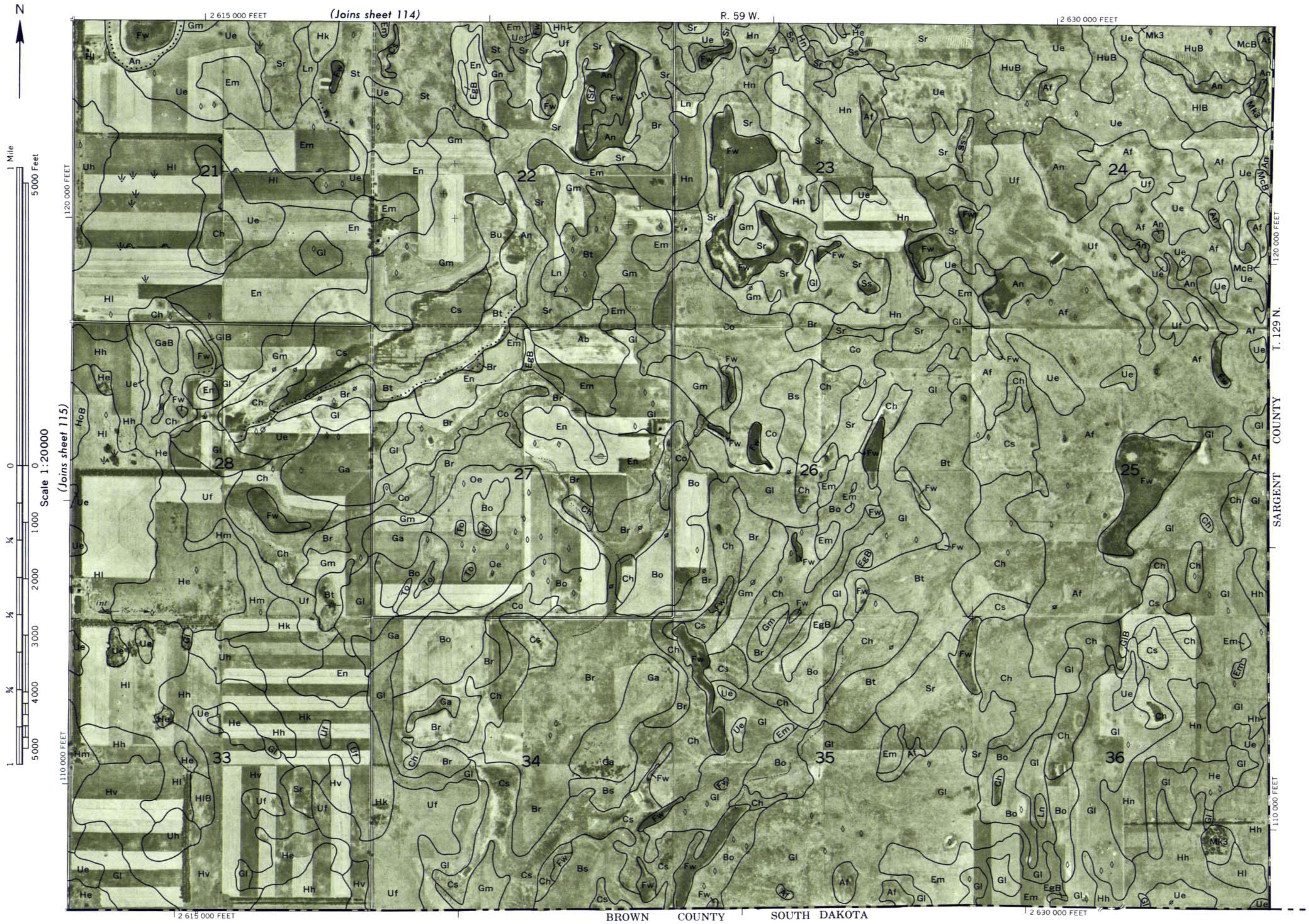
2 590 000 FEET

BROWN COUNTY SOUTH DAKOTA

2 610 000 FEET

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 116



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 116

Land division corners are approximately positioned on this map.

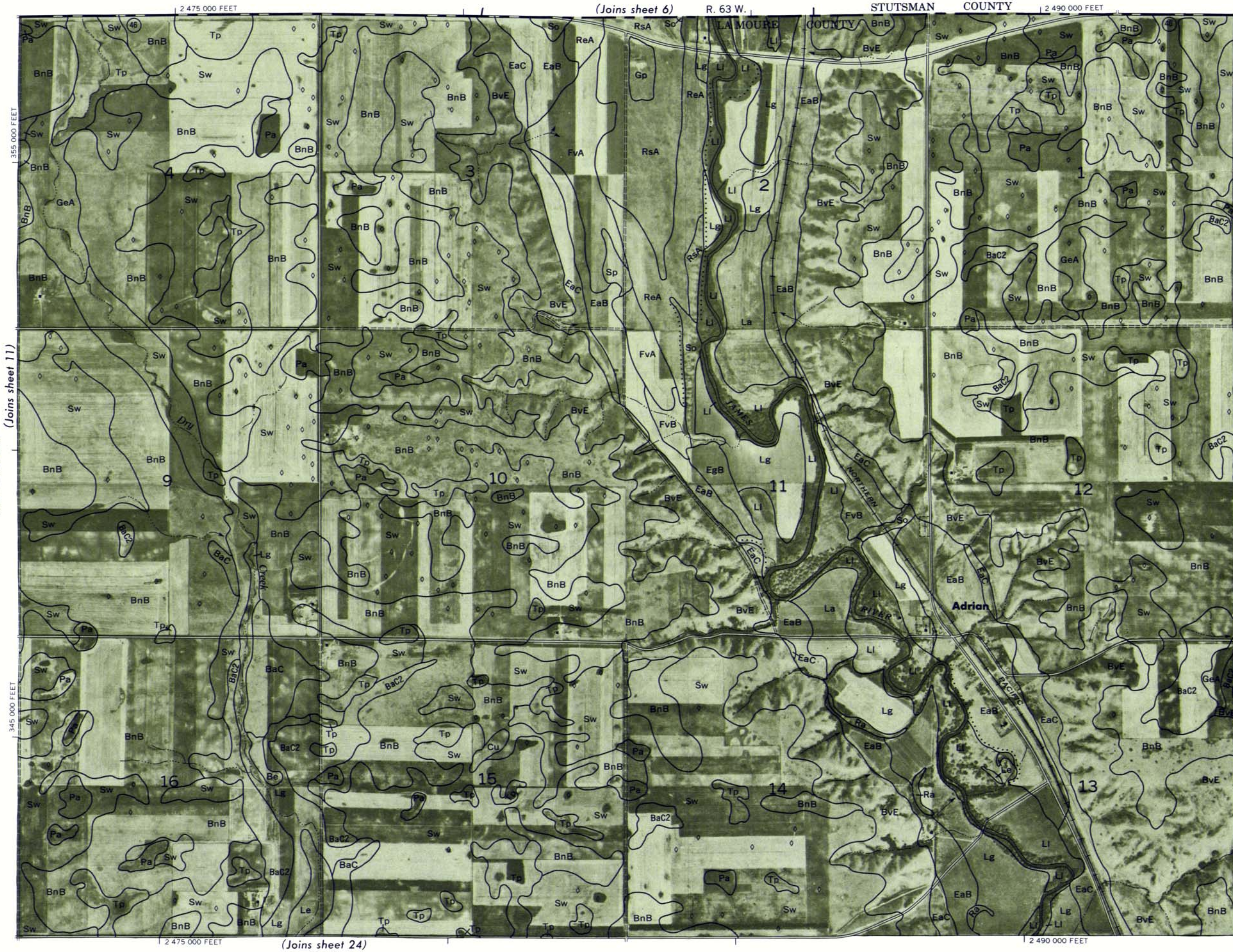
This map is one of a set compiled in 196[illegible] as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 12

N

1 Mile
5000 Feet
Scale 1:20000
0 ¼ ½ ¾ 1
0 1000 2000 3000 4000 5000



Plane coordinate system, 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 12

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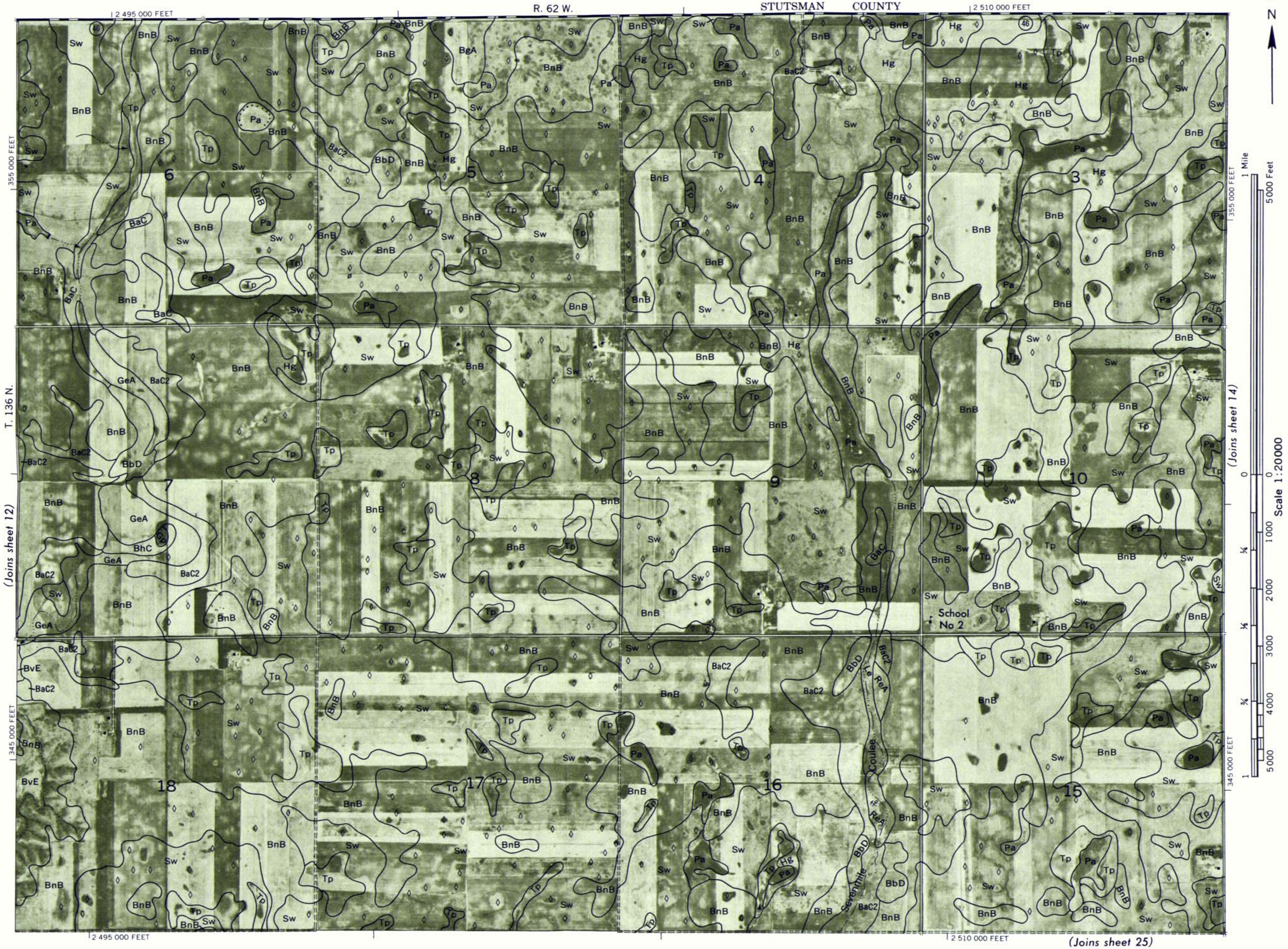
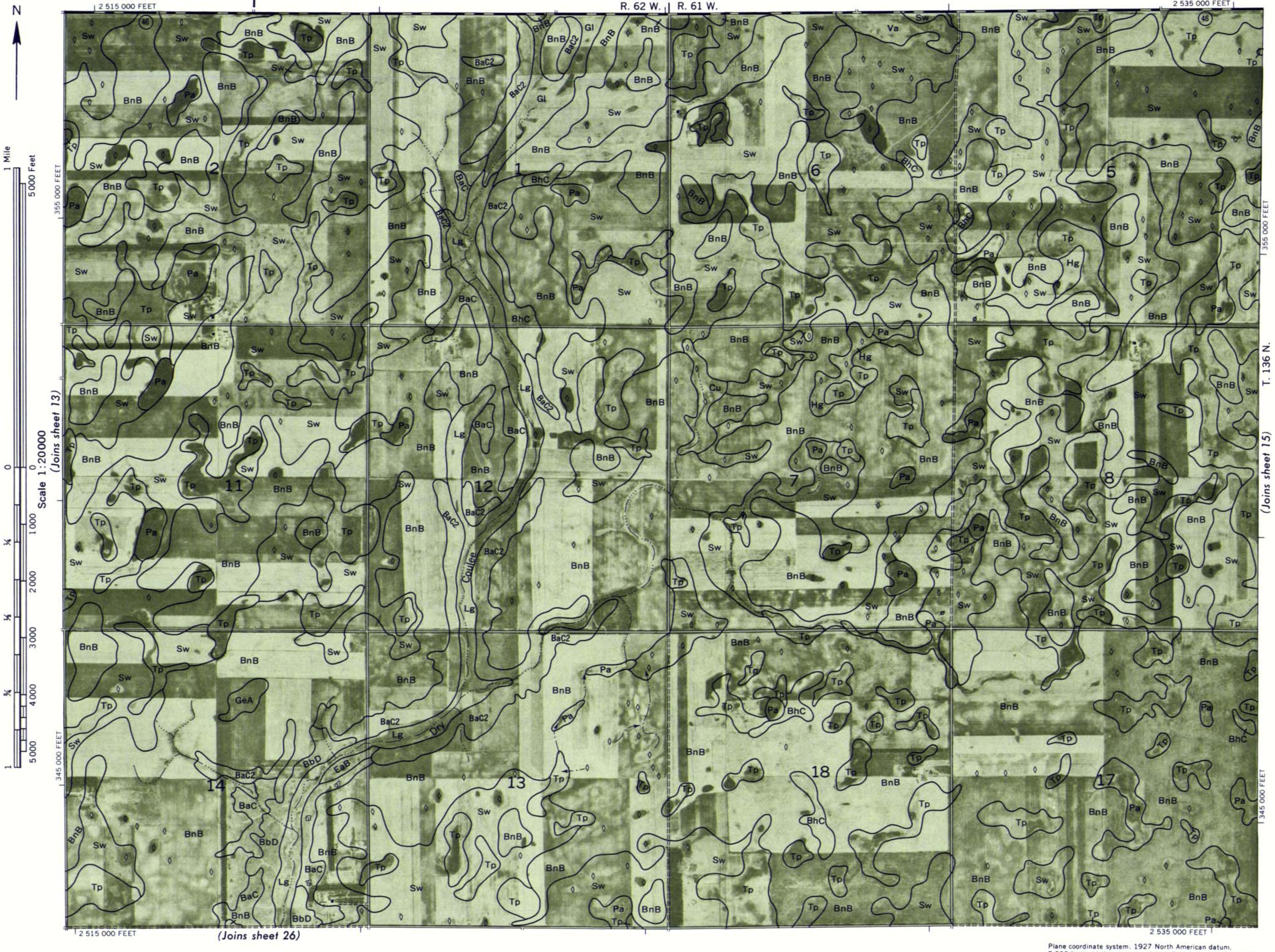
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 13



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 14



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 14

Land division corners are approximately positioned on this map.

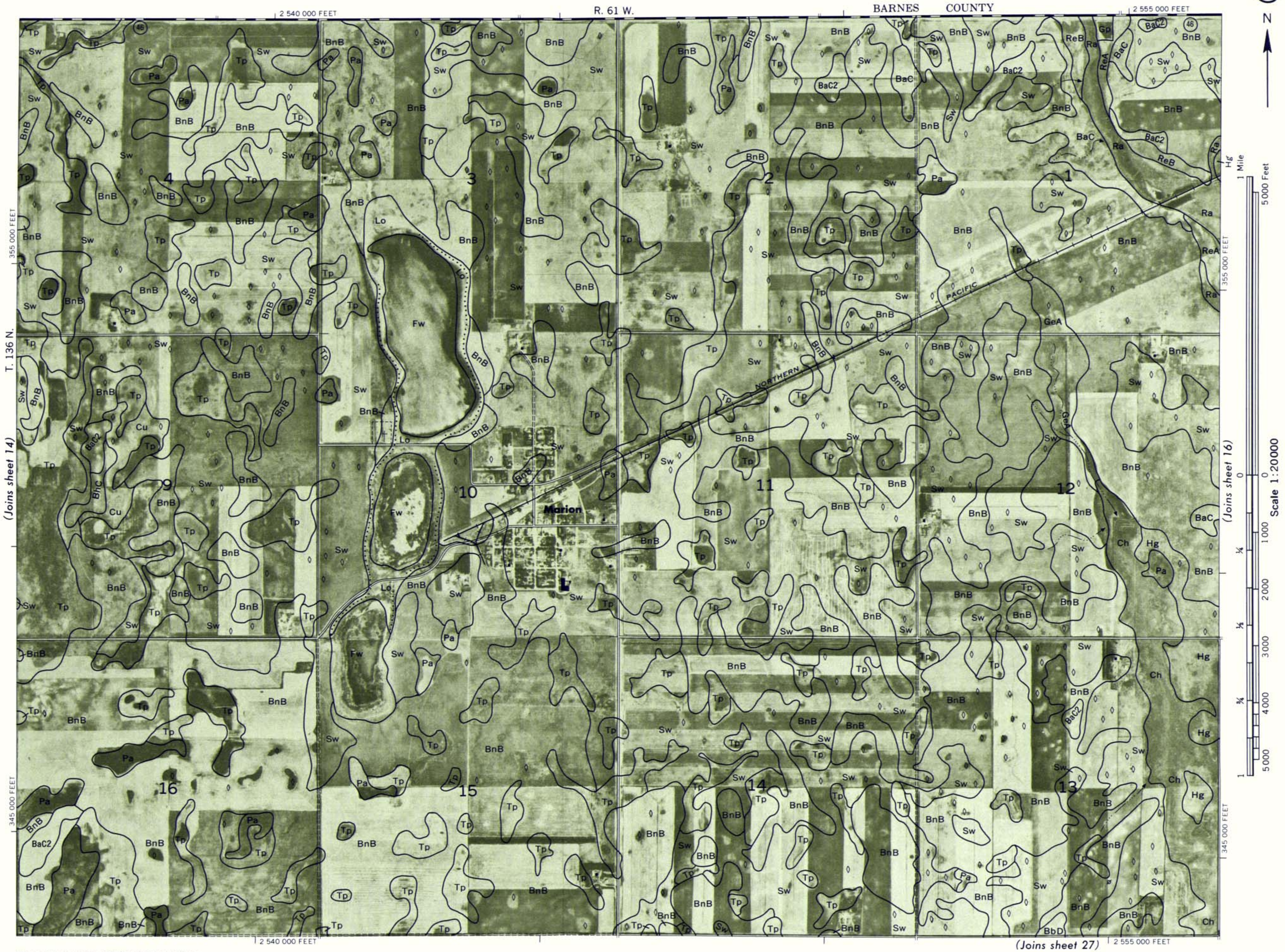
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

15

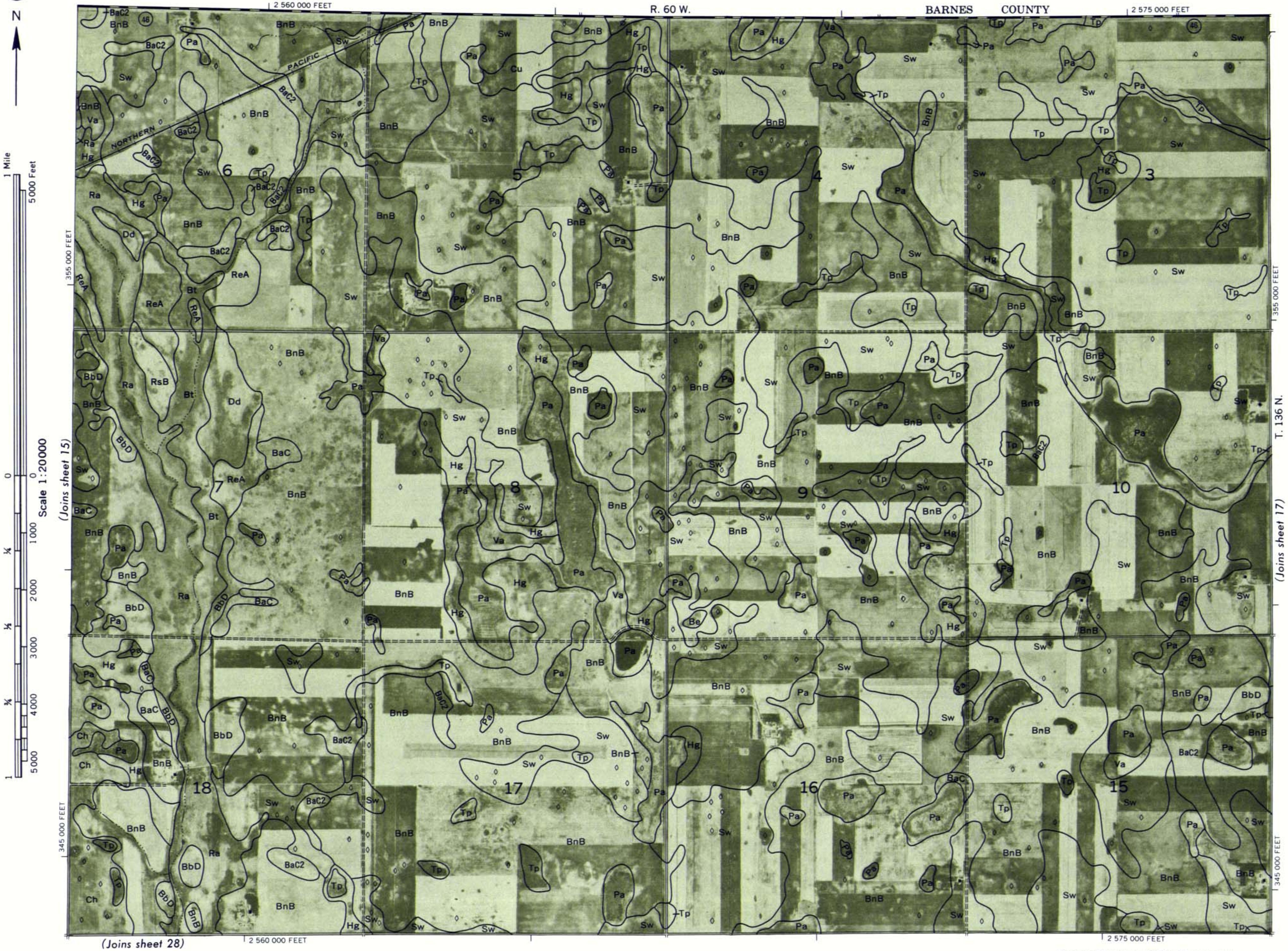
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 15



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 16



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 16

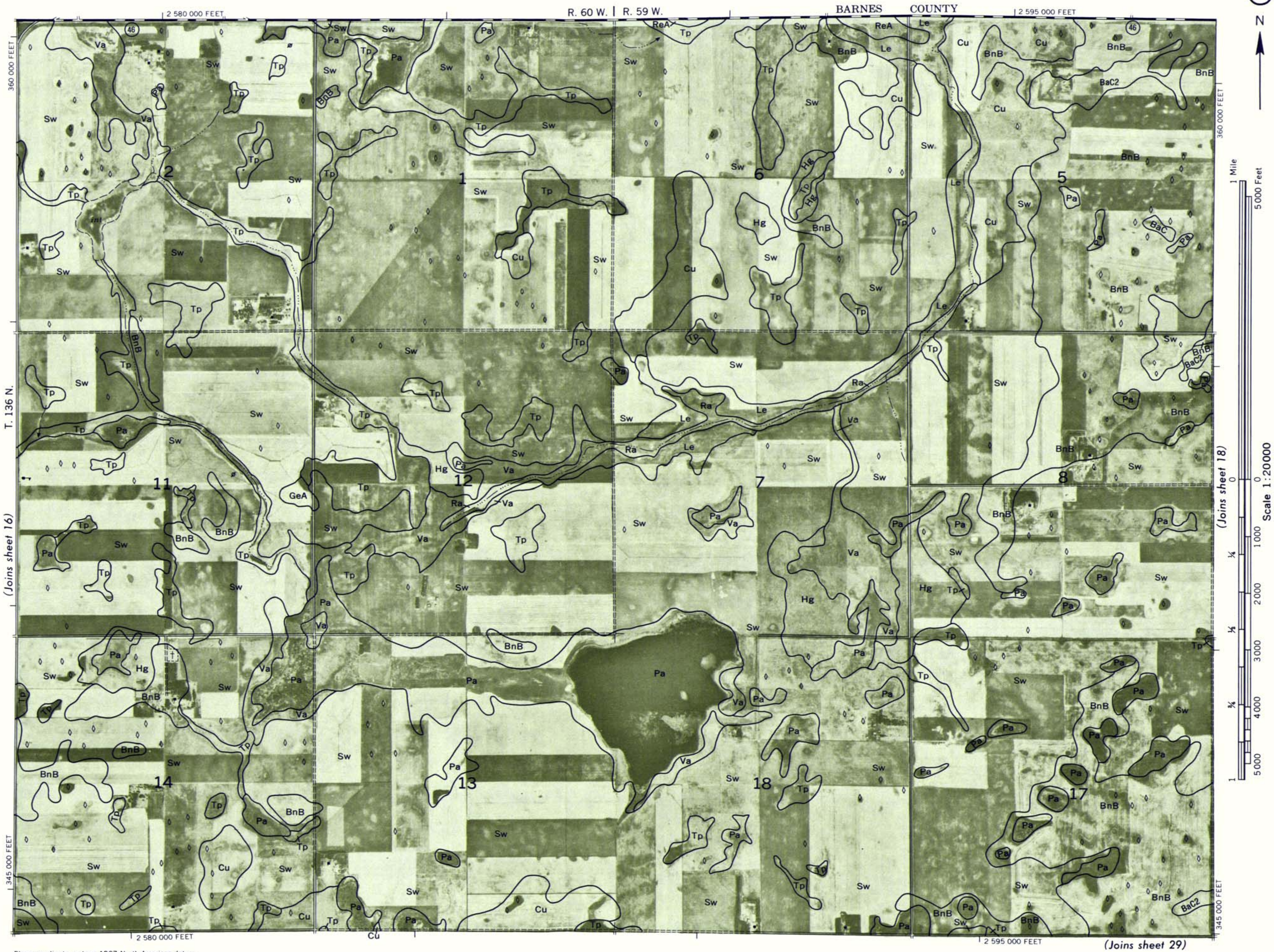
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969, as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 17



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

N

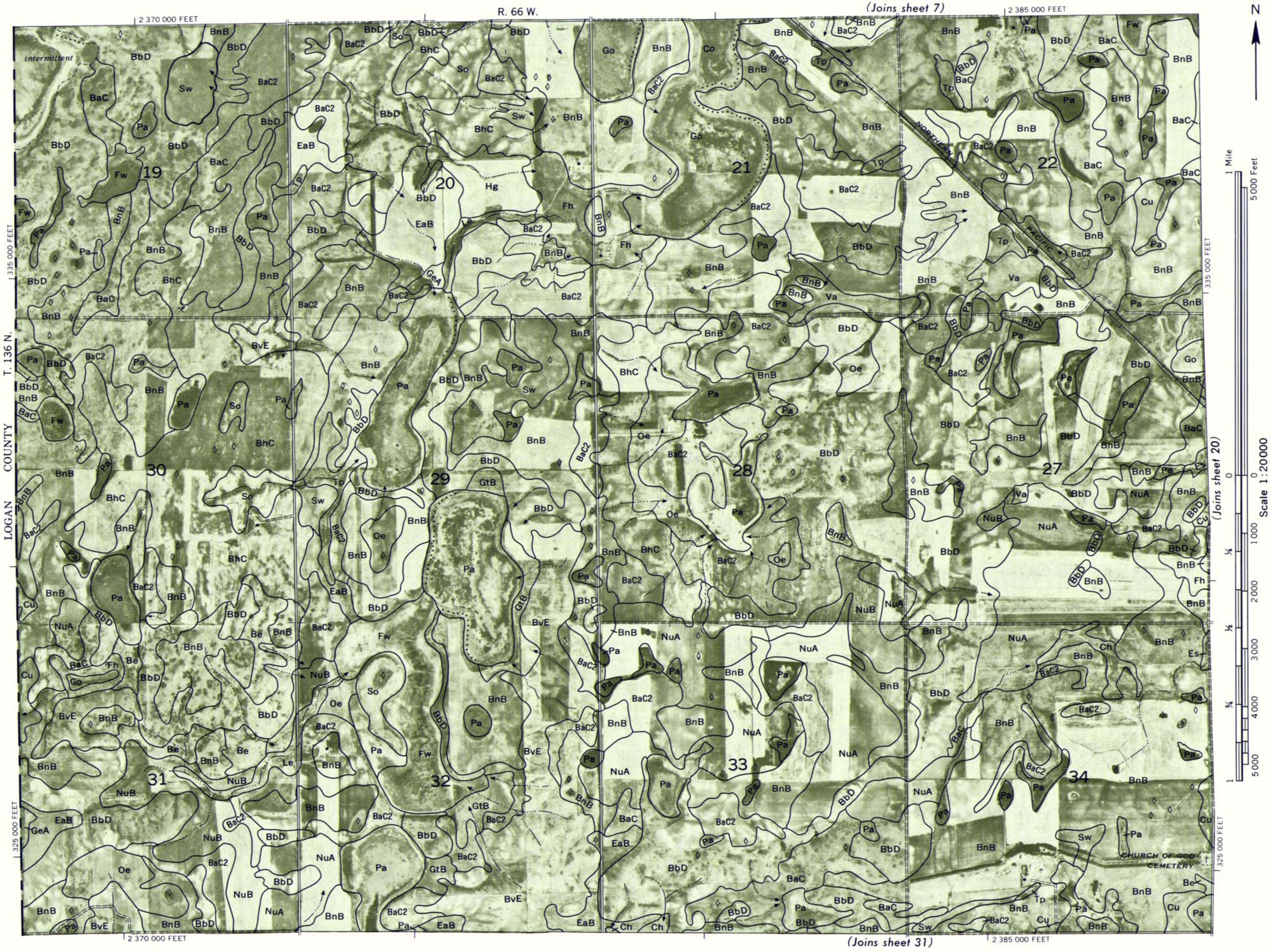
1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 18

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 19

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 2

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 2

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 20

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 20

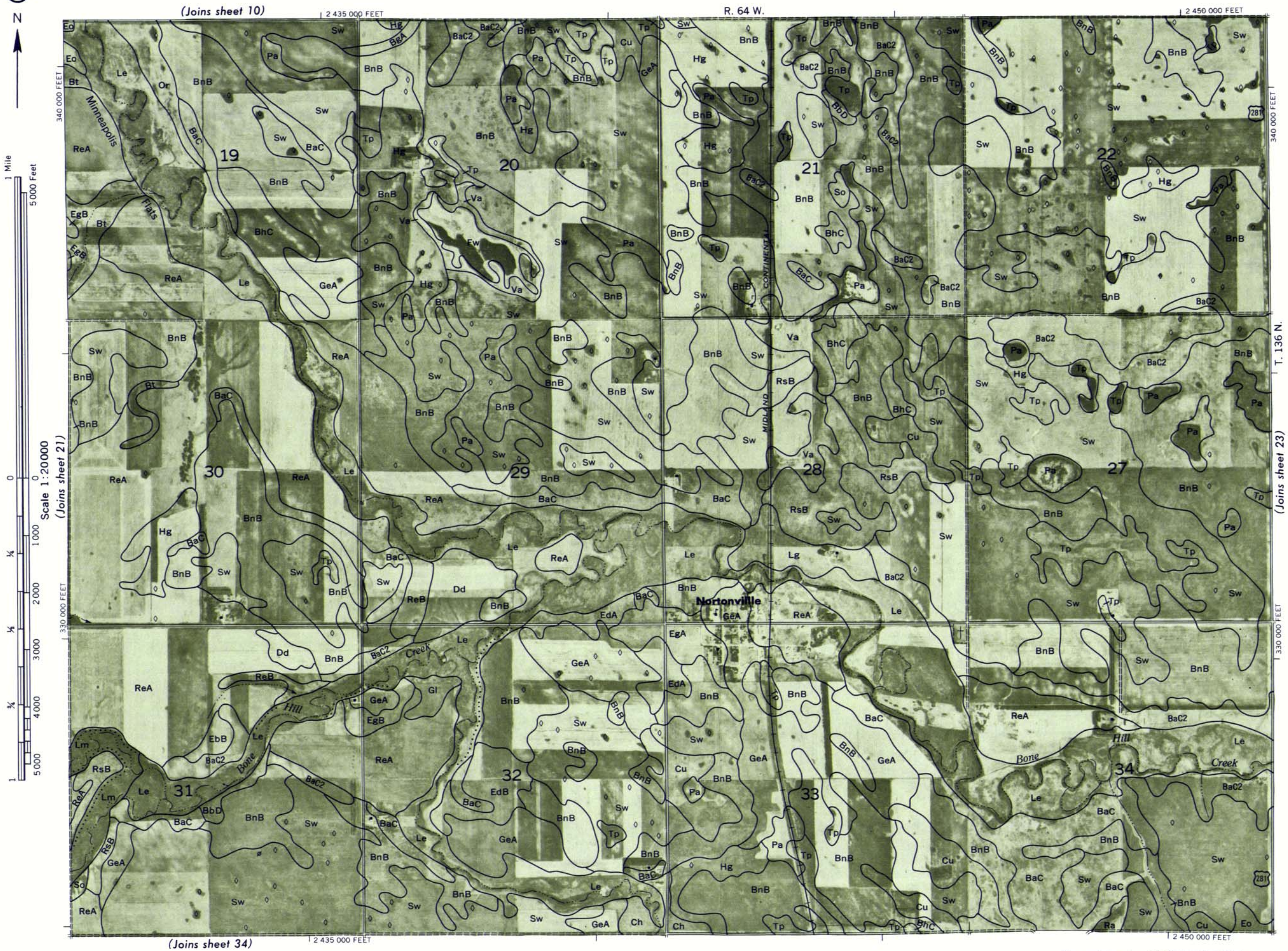
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 21

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



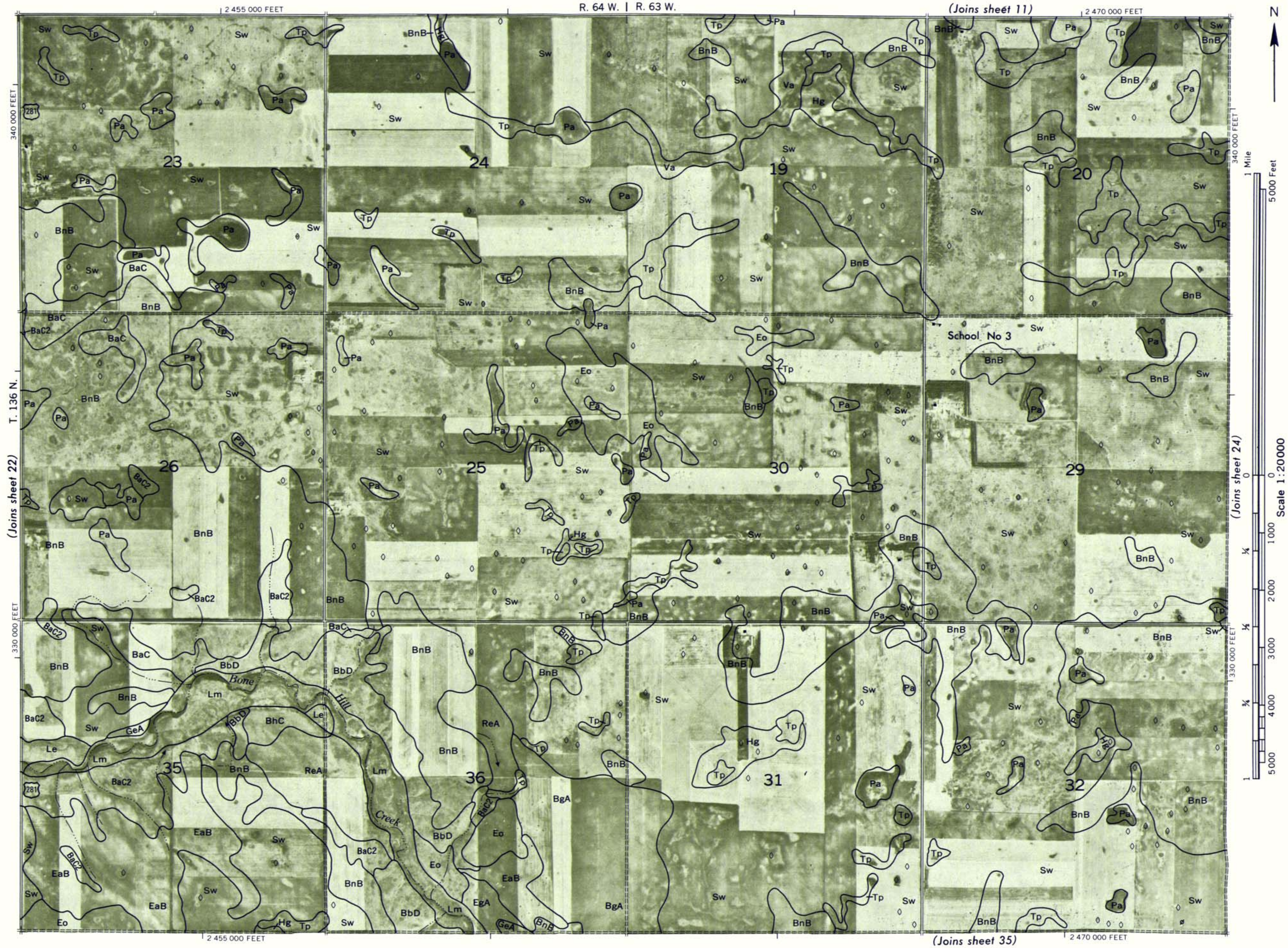
Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 22

Land division corners are approximately positioned on this map.

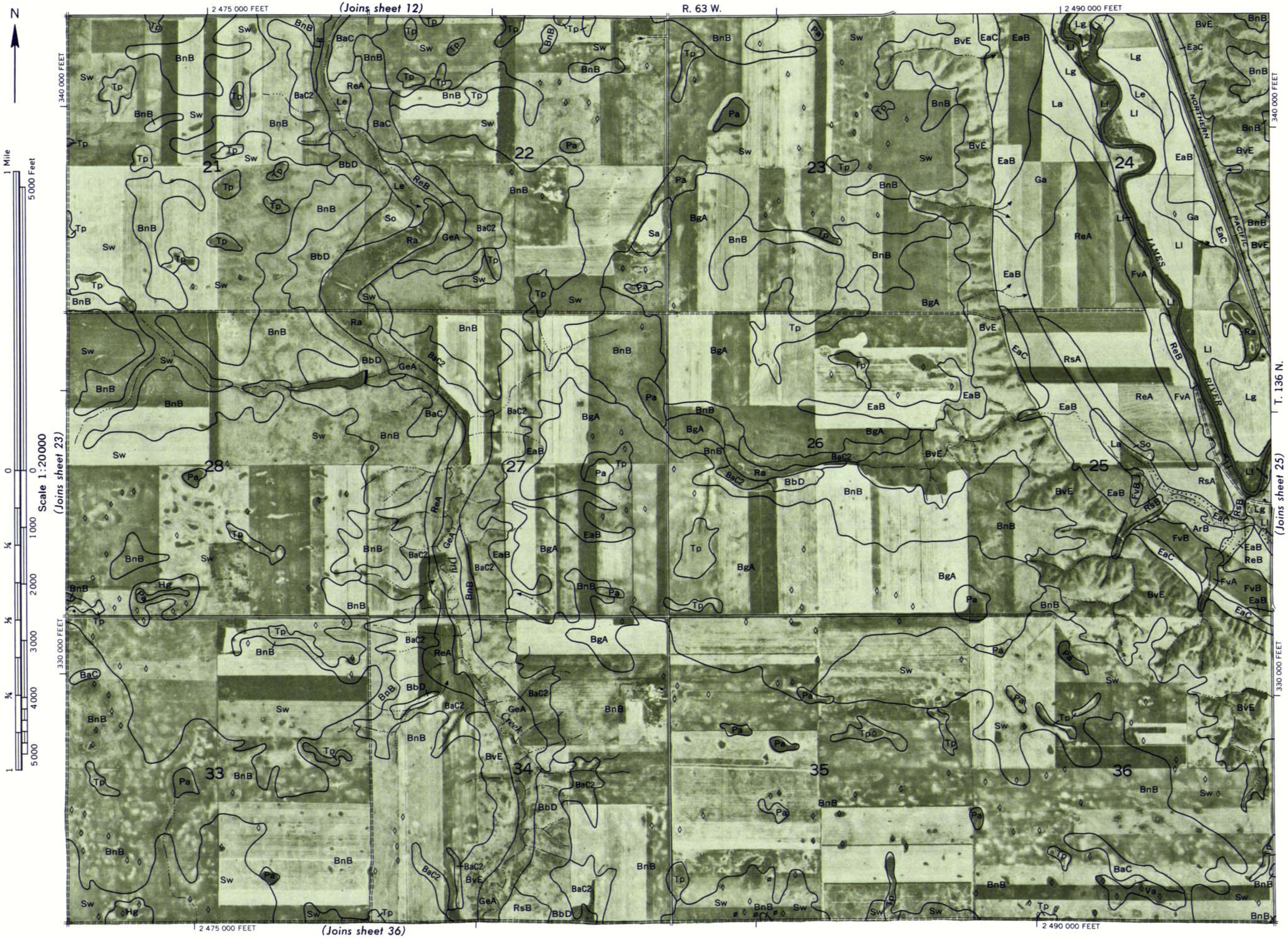
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 24



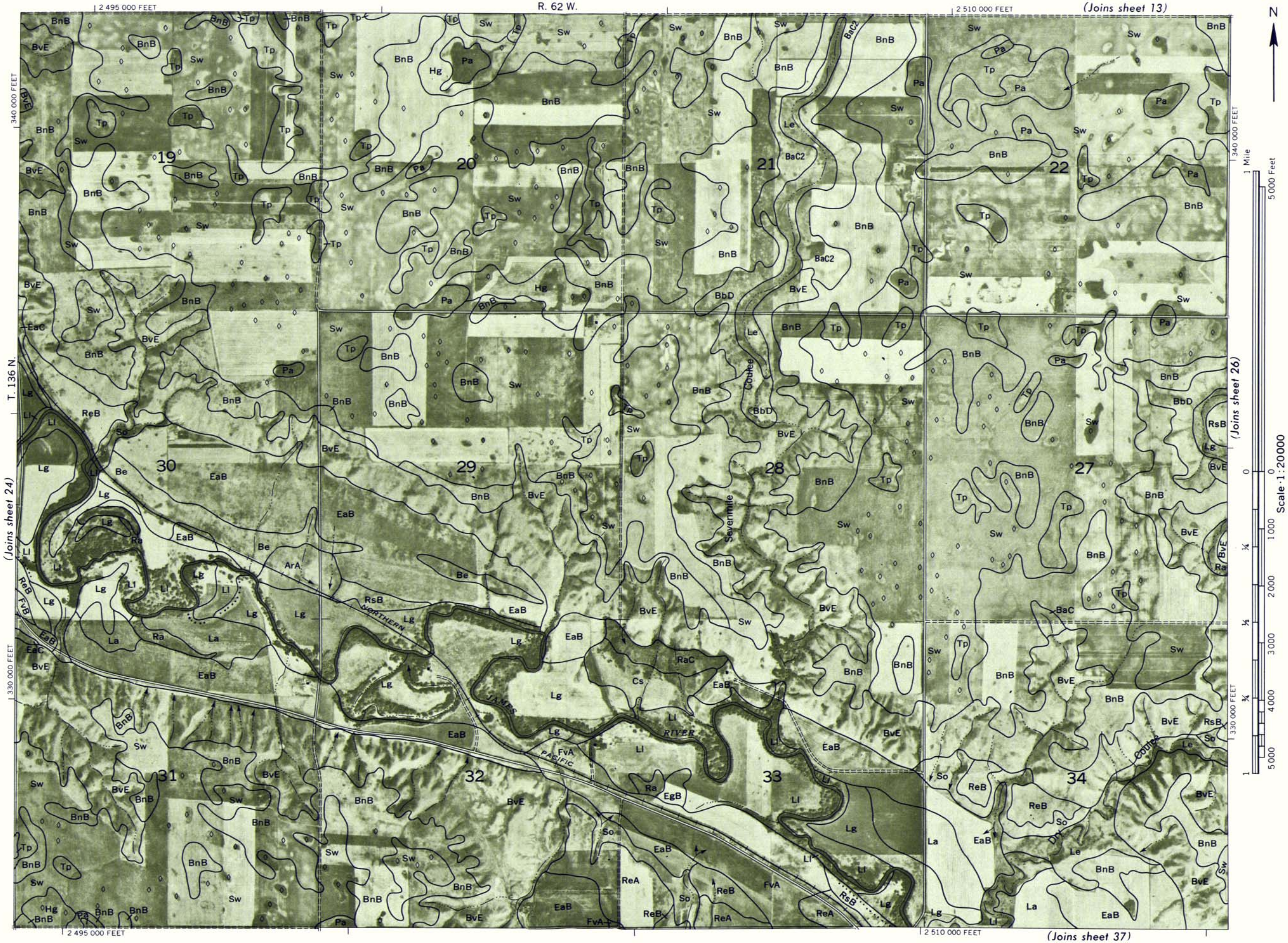
Plane coordinate system. 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 25



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

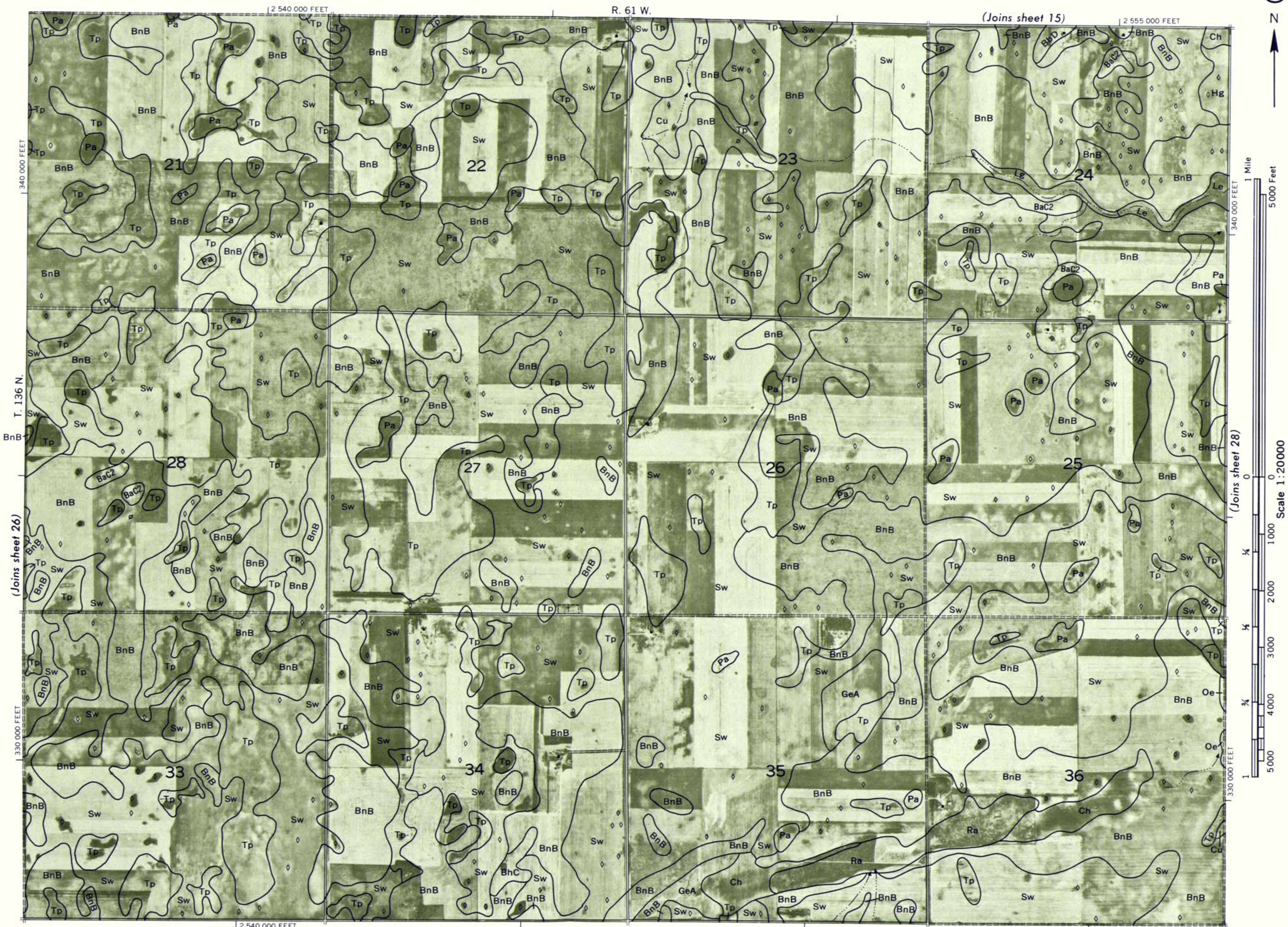
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 26

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 26

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system, 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

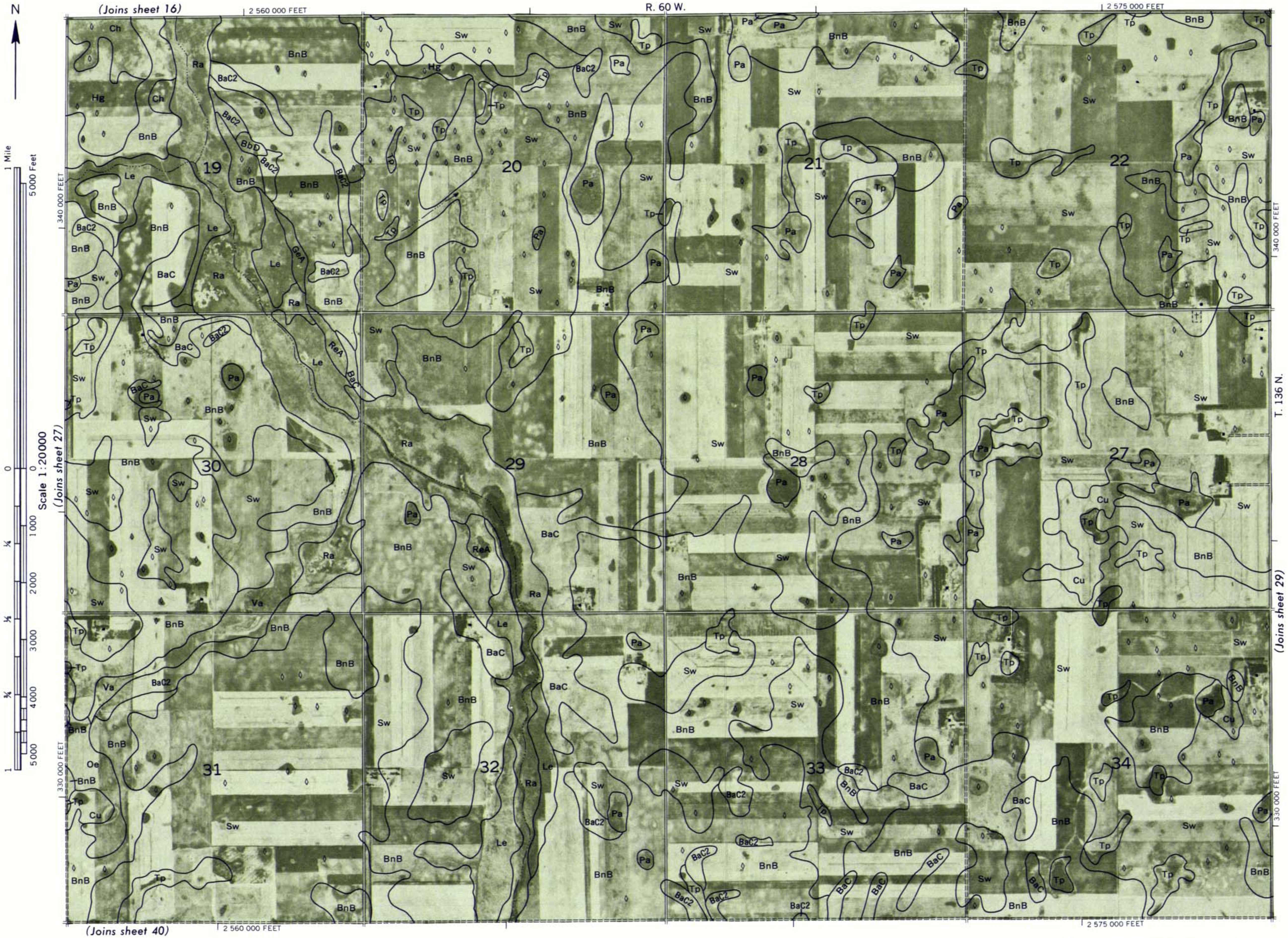


Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 196[illegible] as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 27

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 28

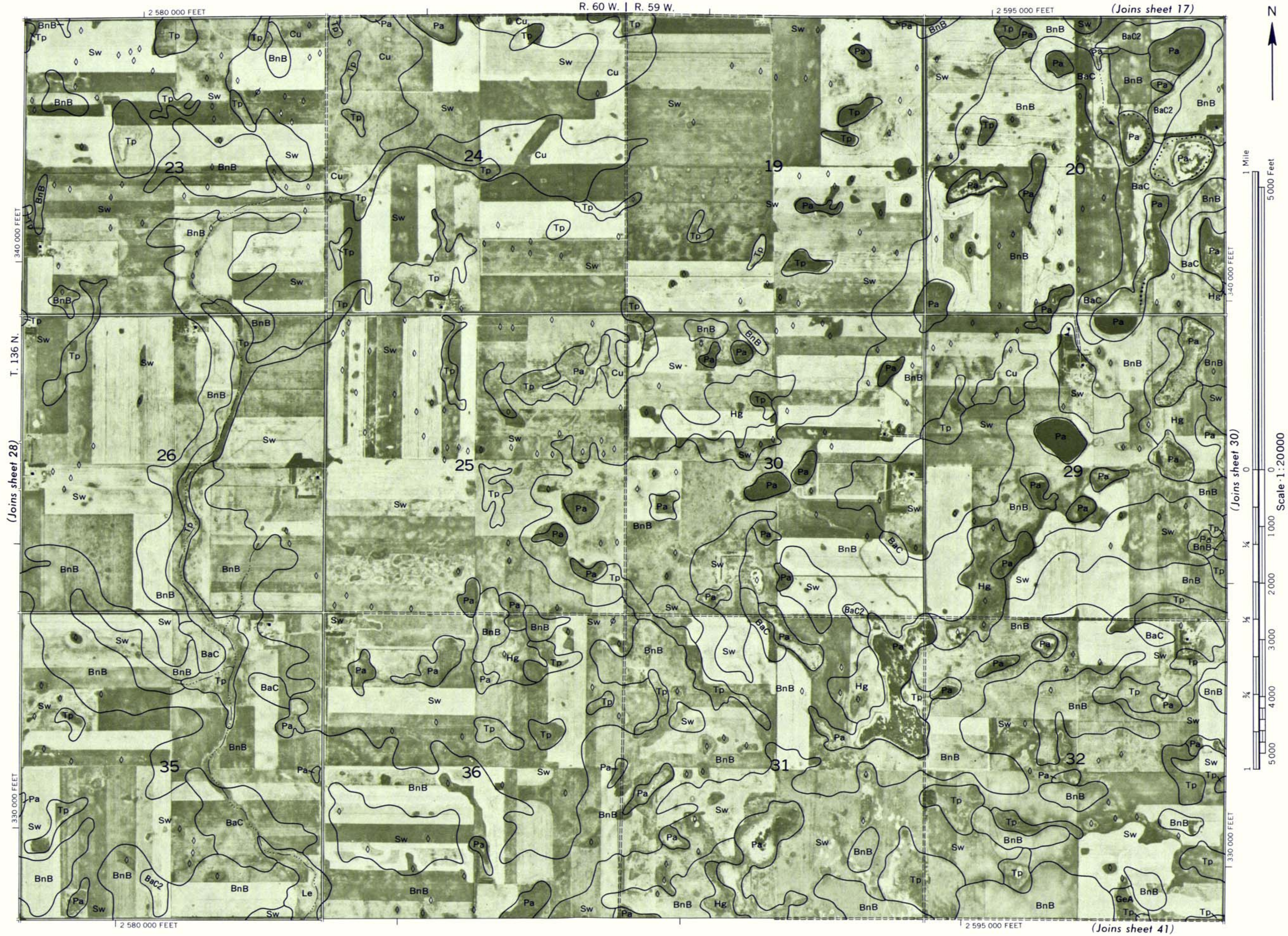


Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 28

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

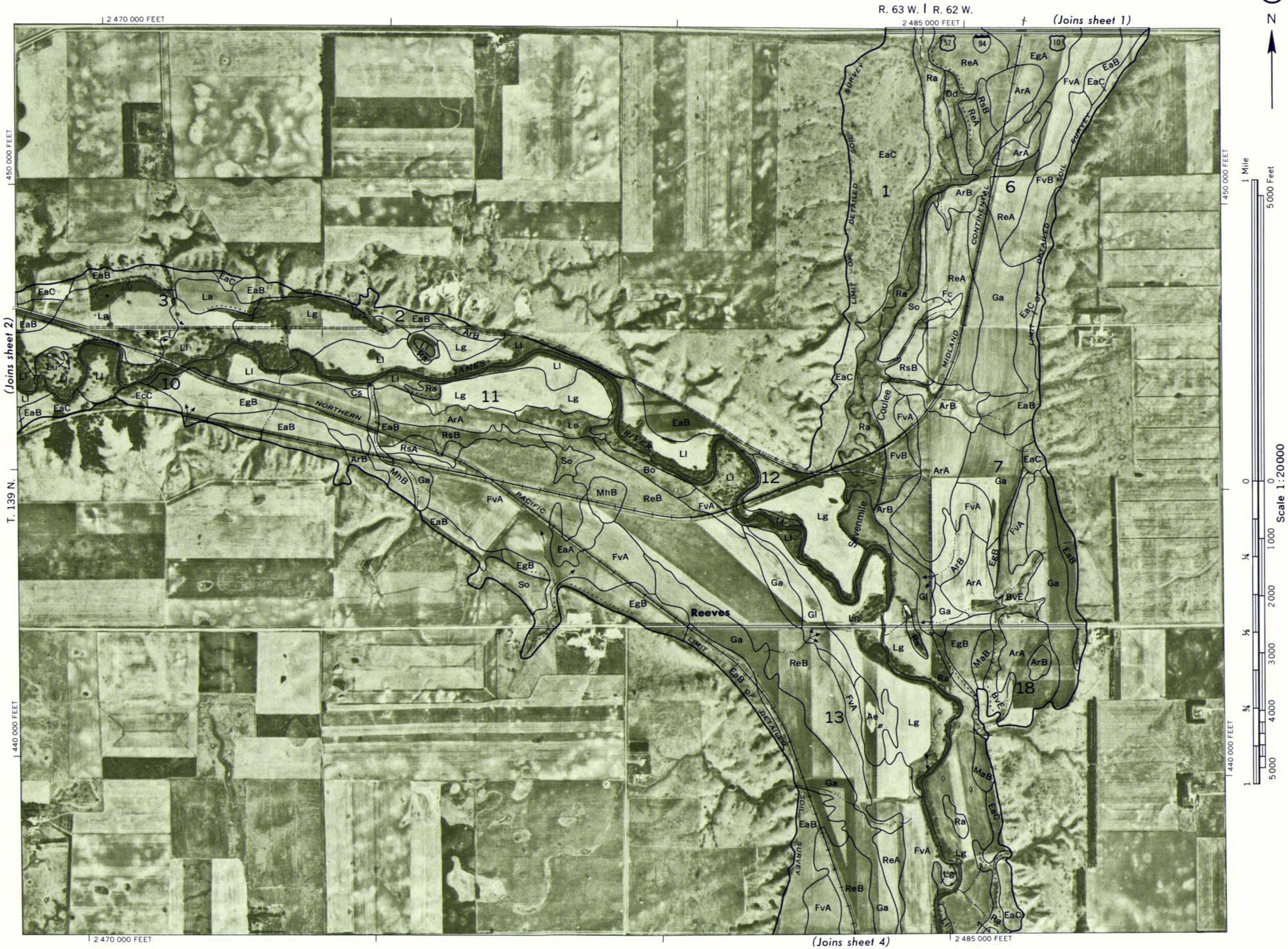


Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

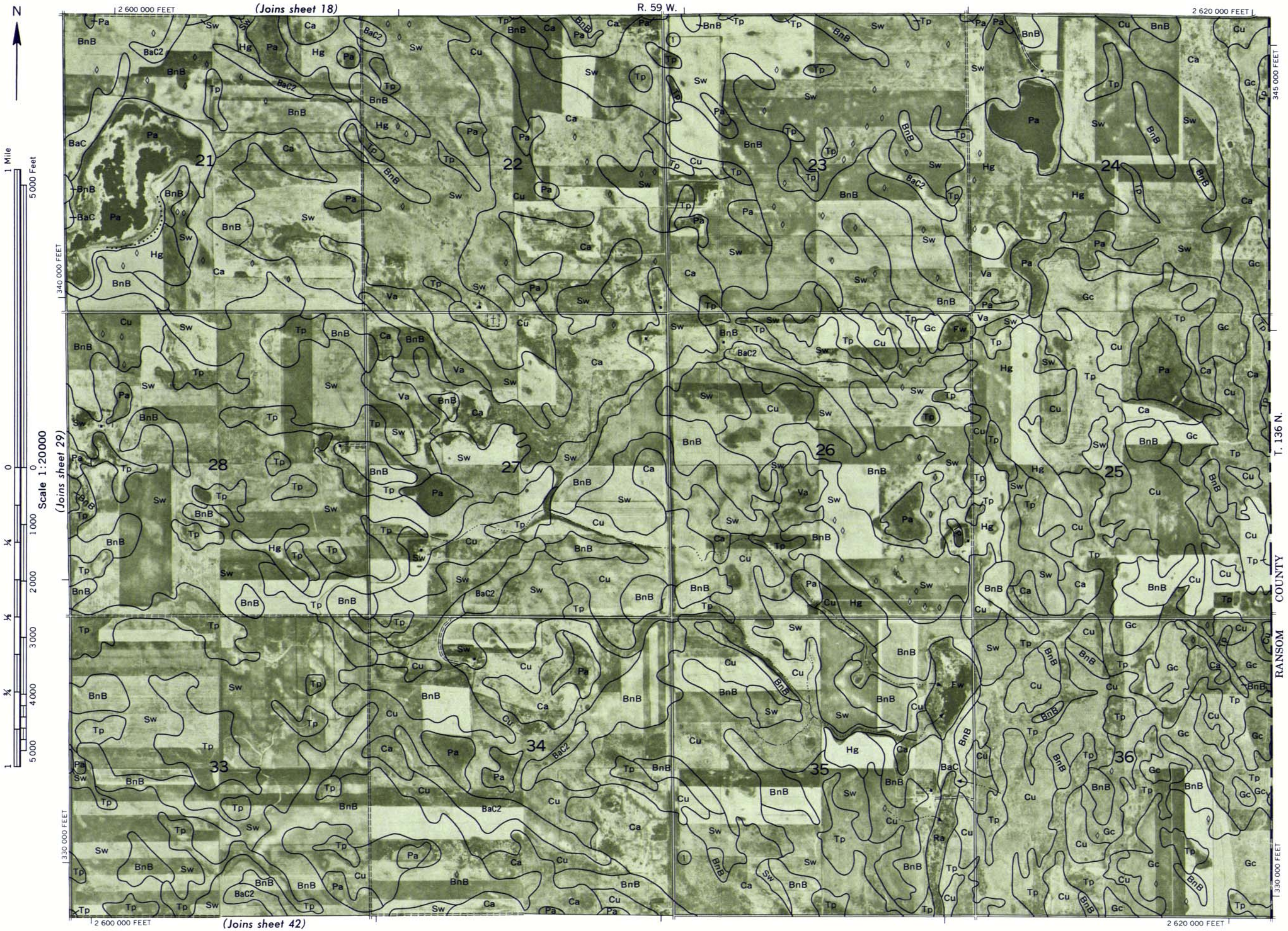
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 3



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 30



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 30

Land division corners are approximately positioned on this map.

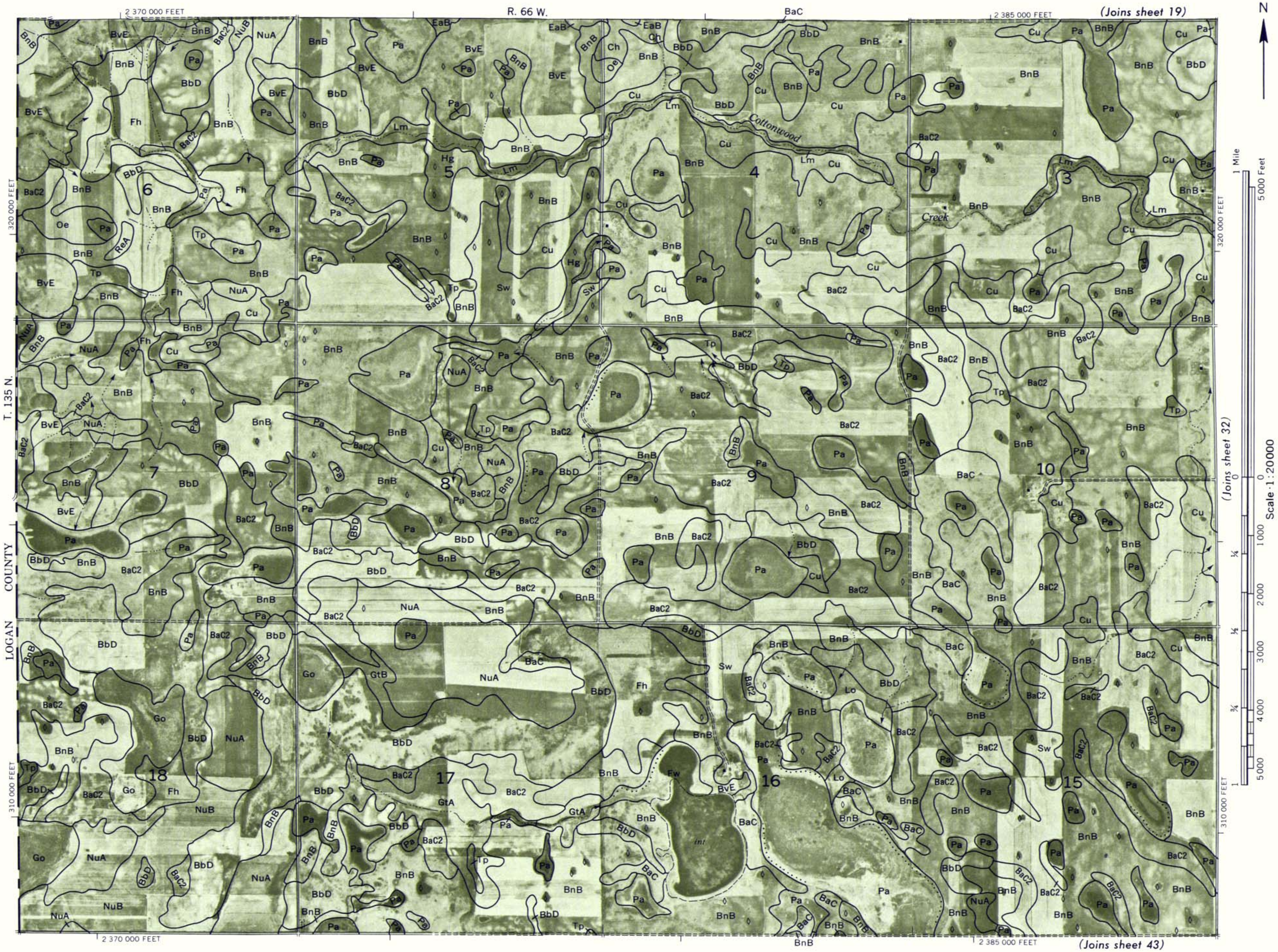
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 31



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

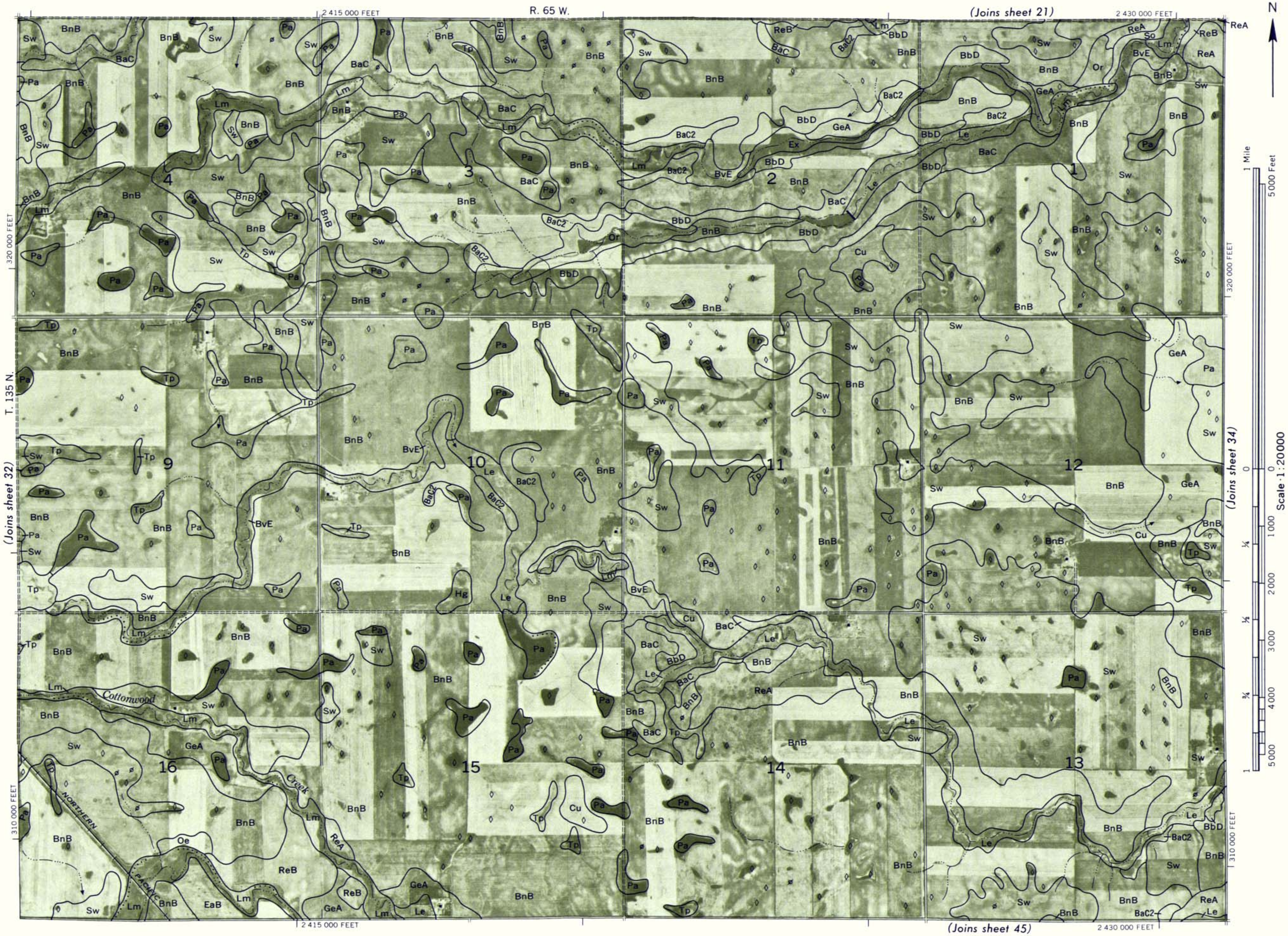
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 32

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 32

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



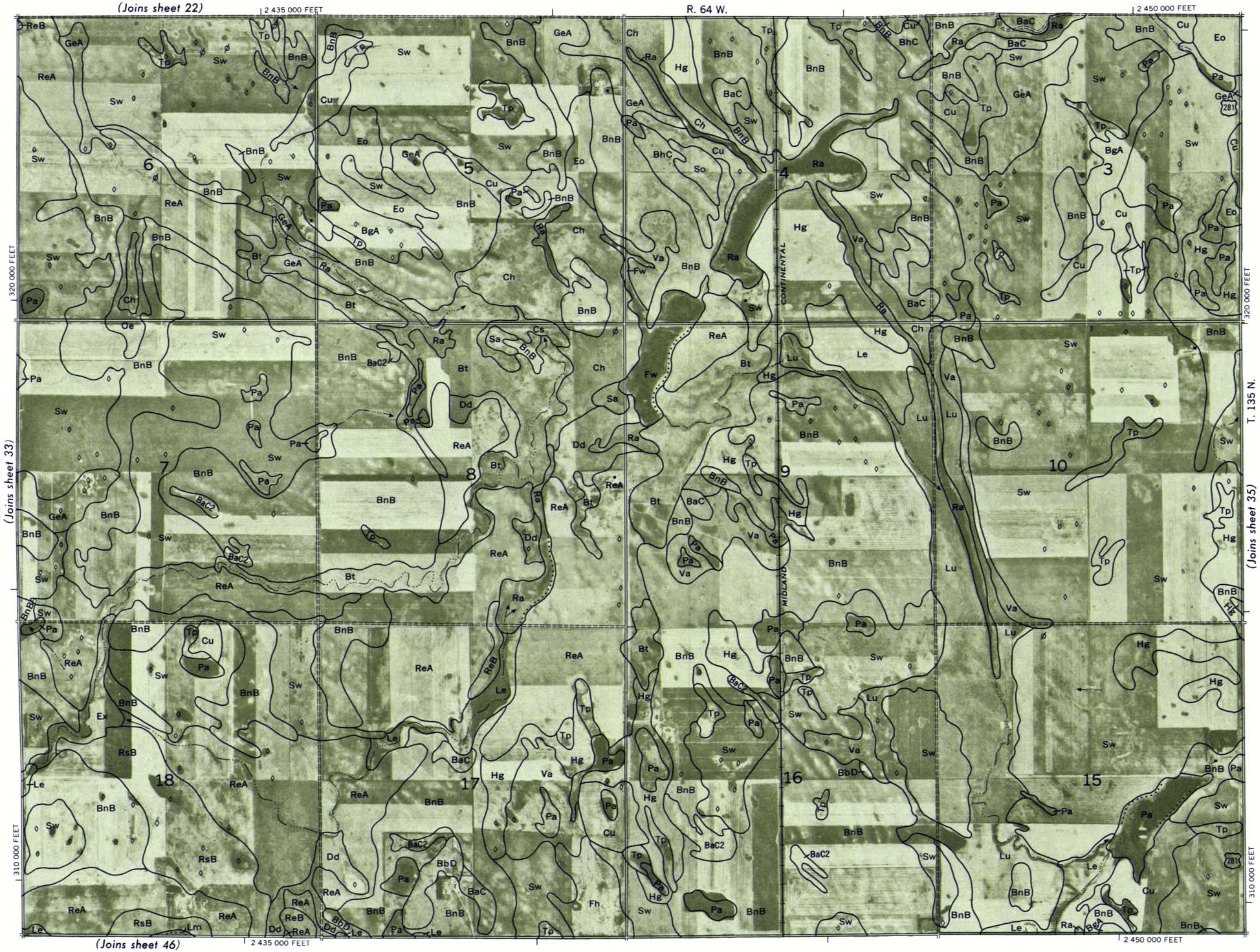
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 33

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 34

N



Scale 1:20000

1 Mile

5000 Feet

0 1000 2000 3000 4000 5000

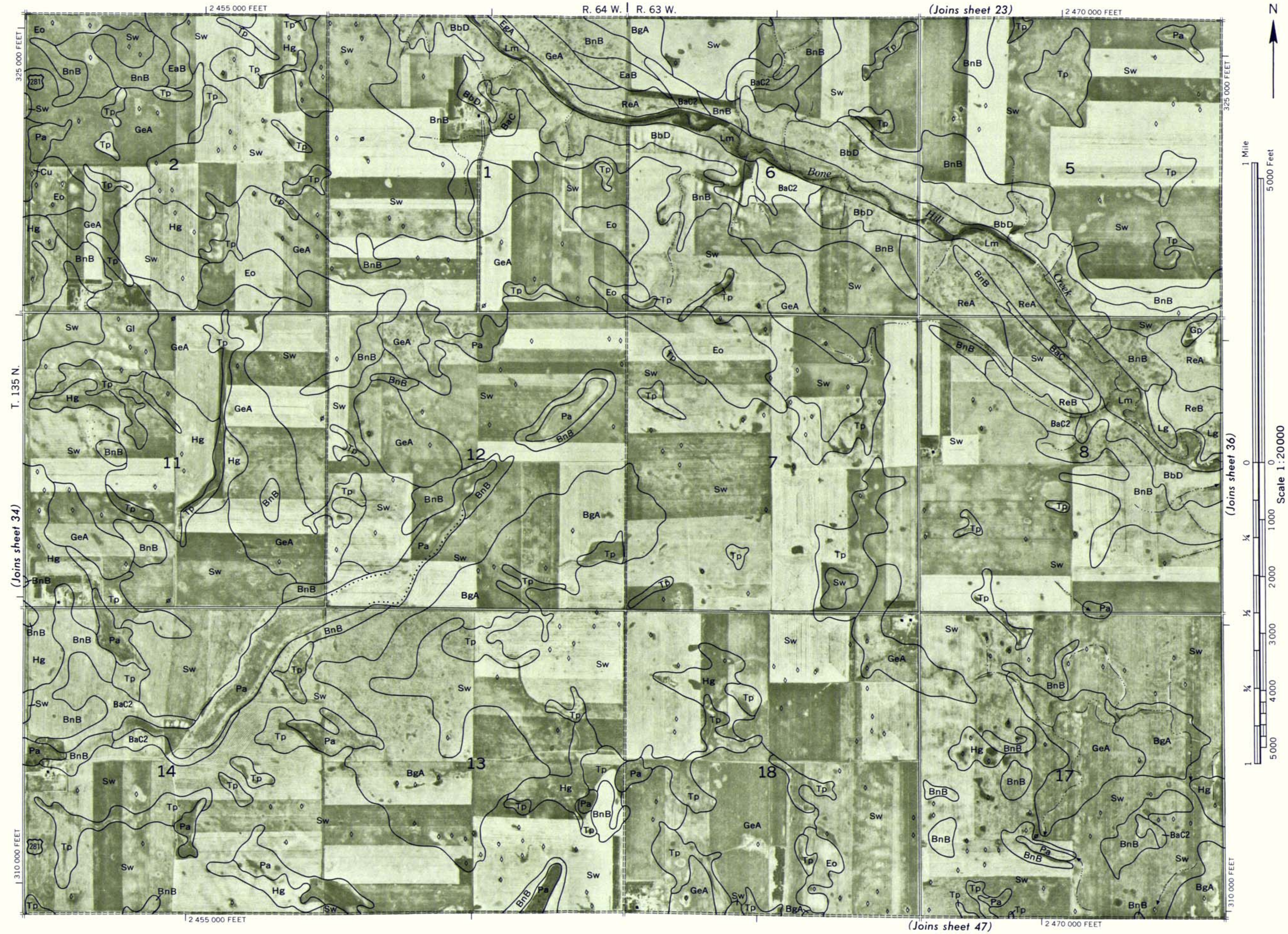
0 ¼ ½ ¾ 1

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 34

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 36

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 36

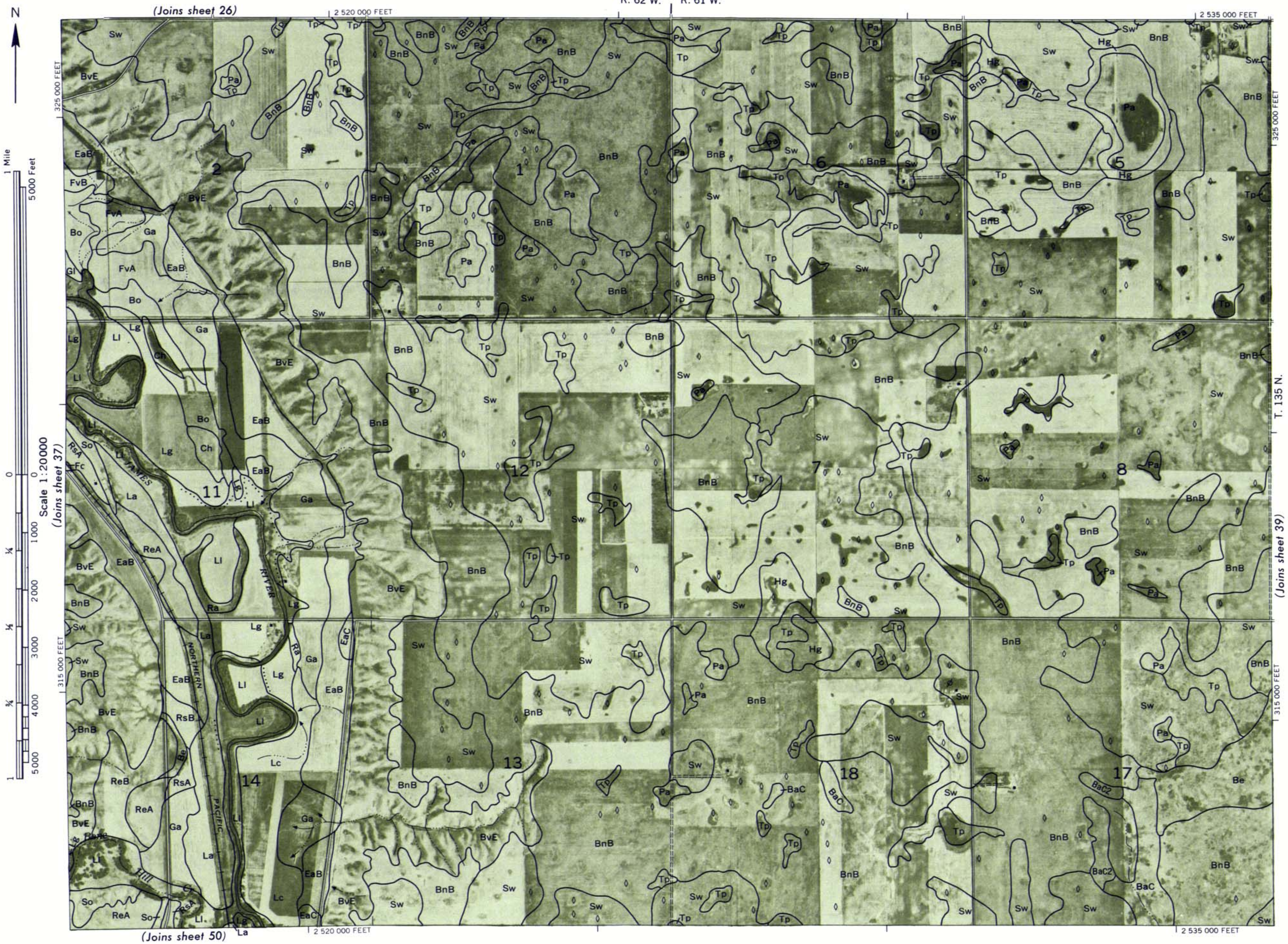
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 37

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 38

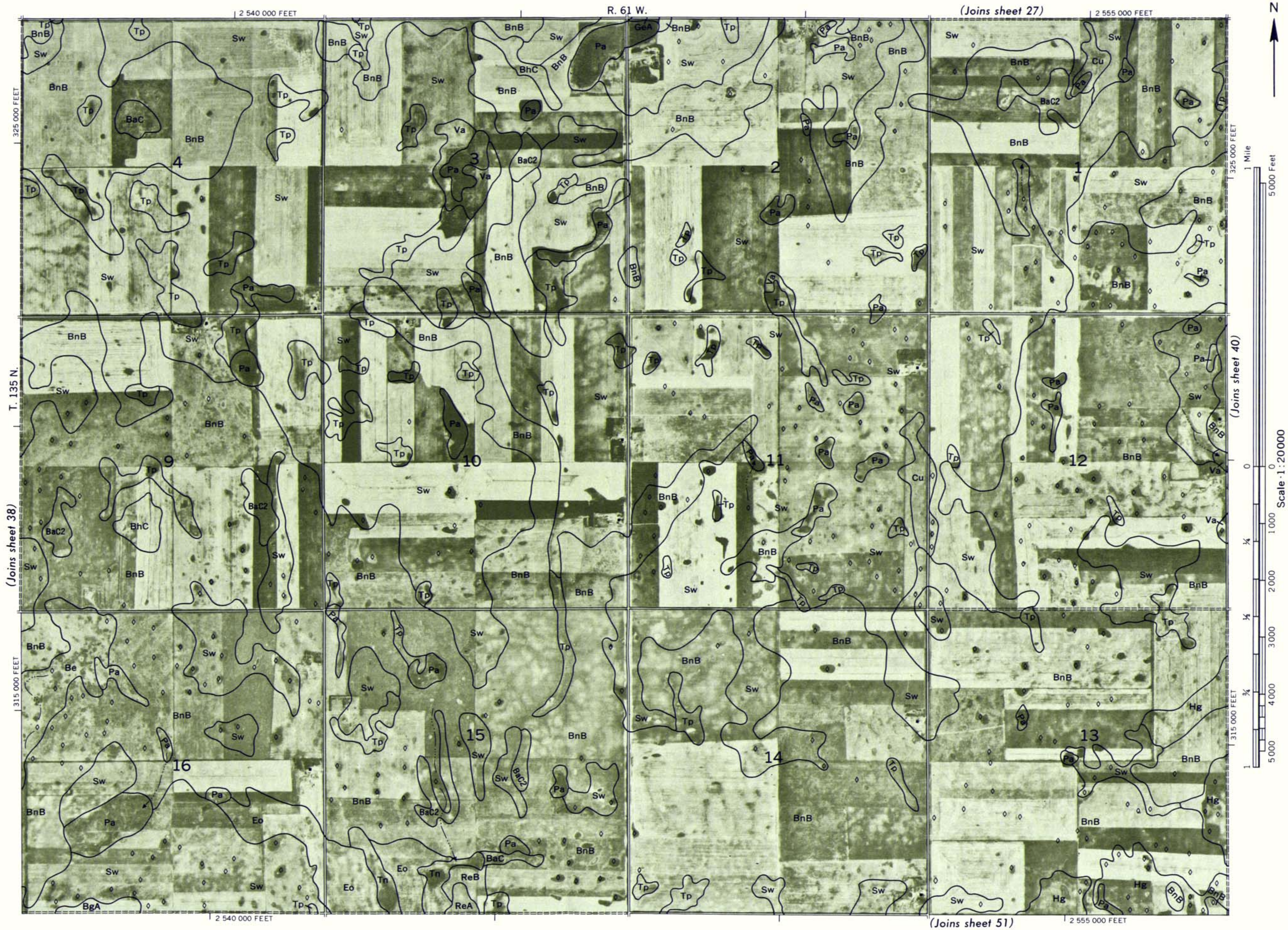
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

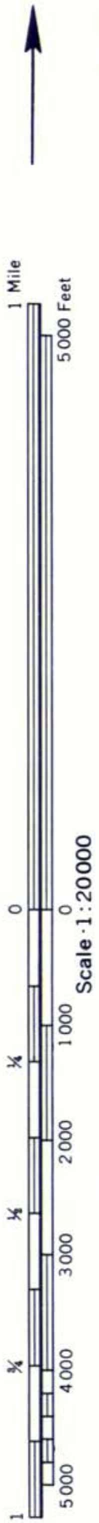
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

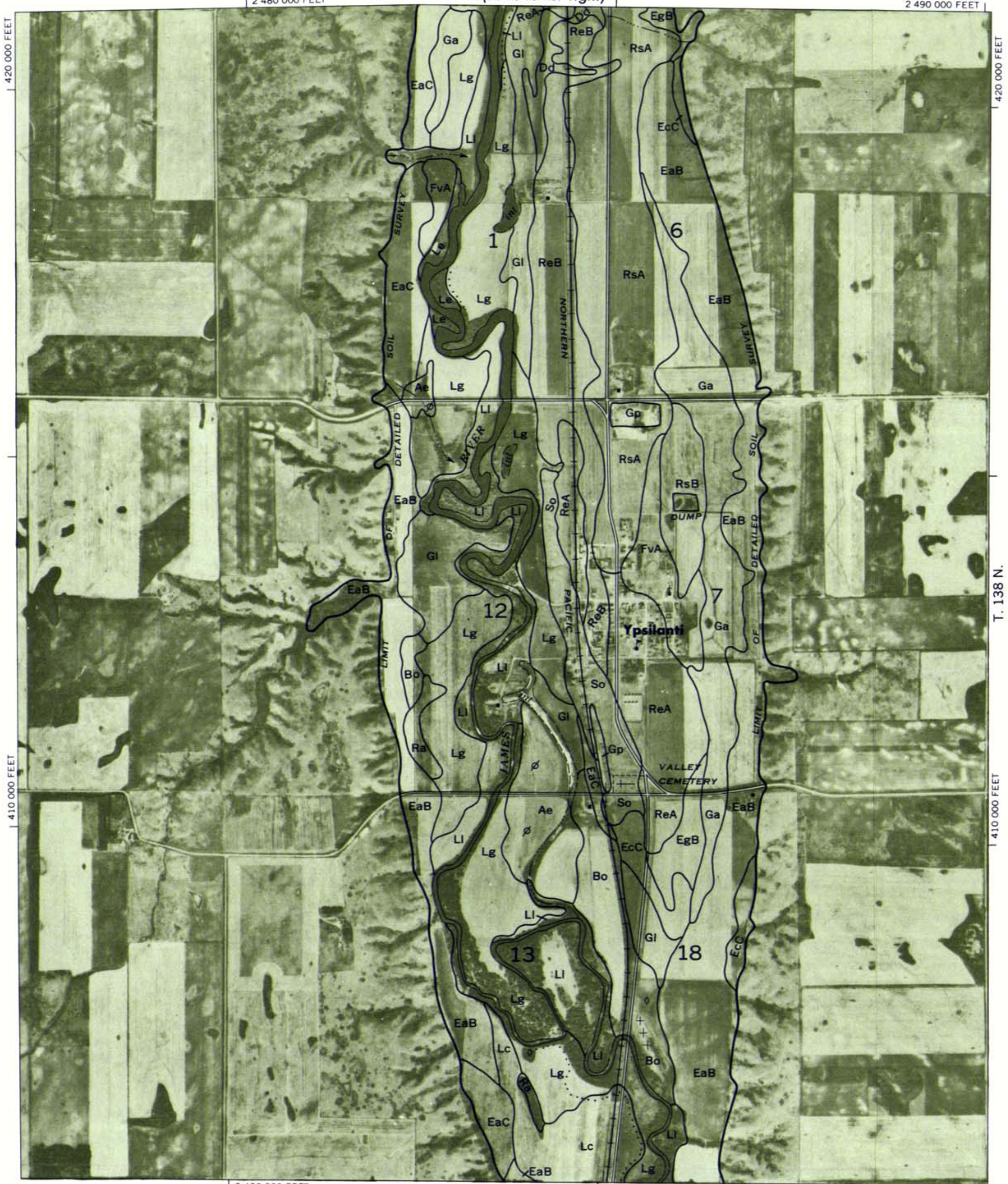
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 39

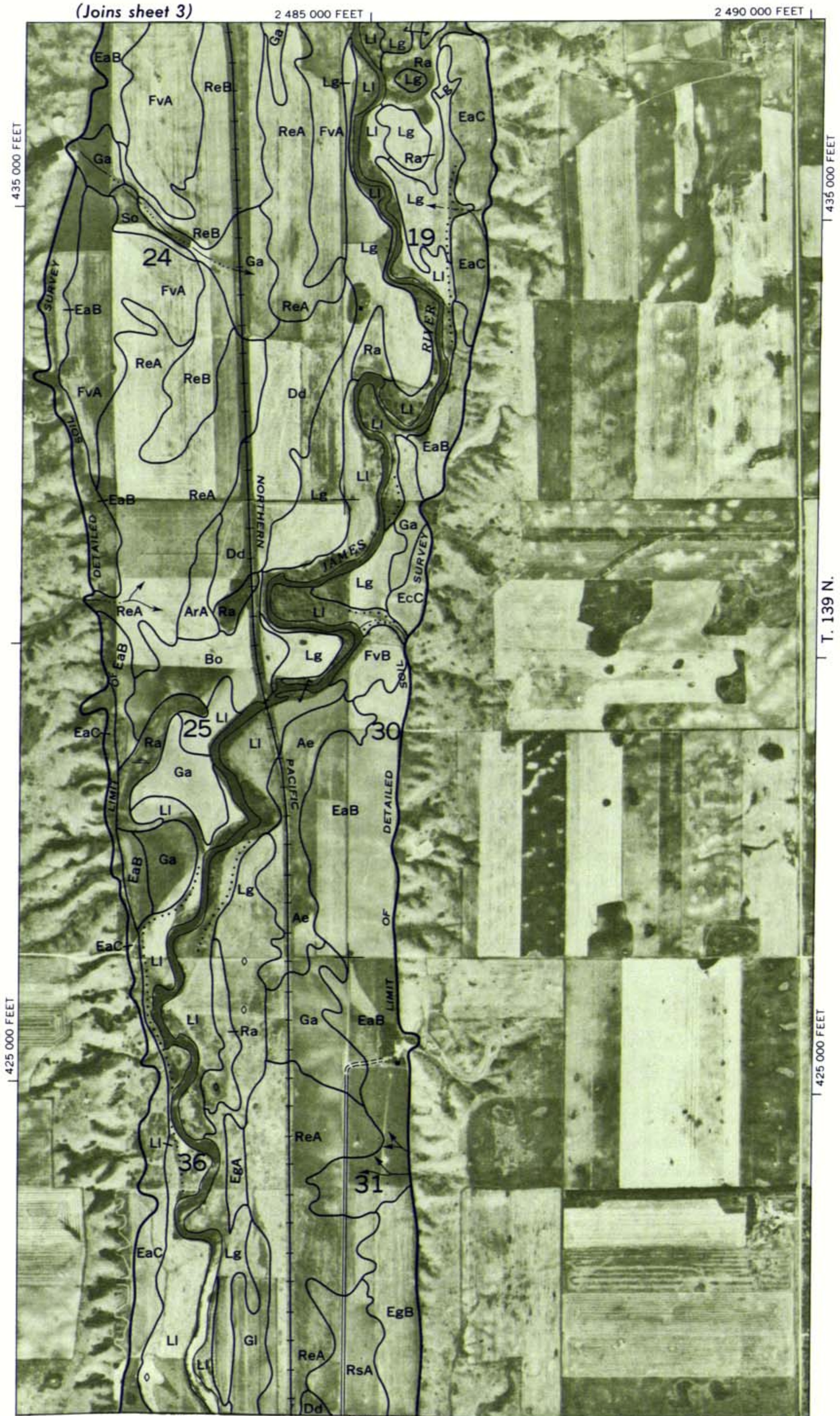


Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 4







LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 4

Land division corners are approximately positioned on this map.

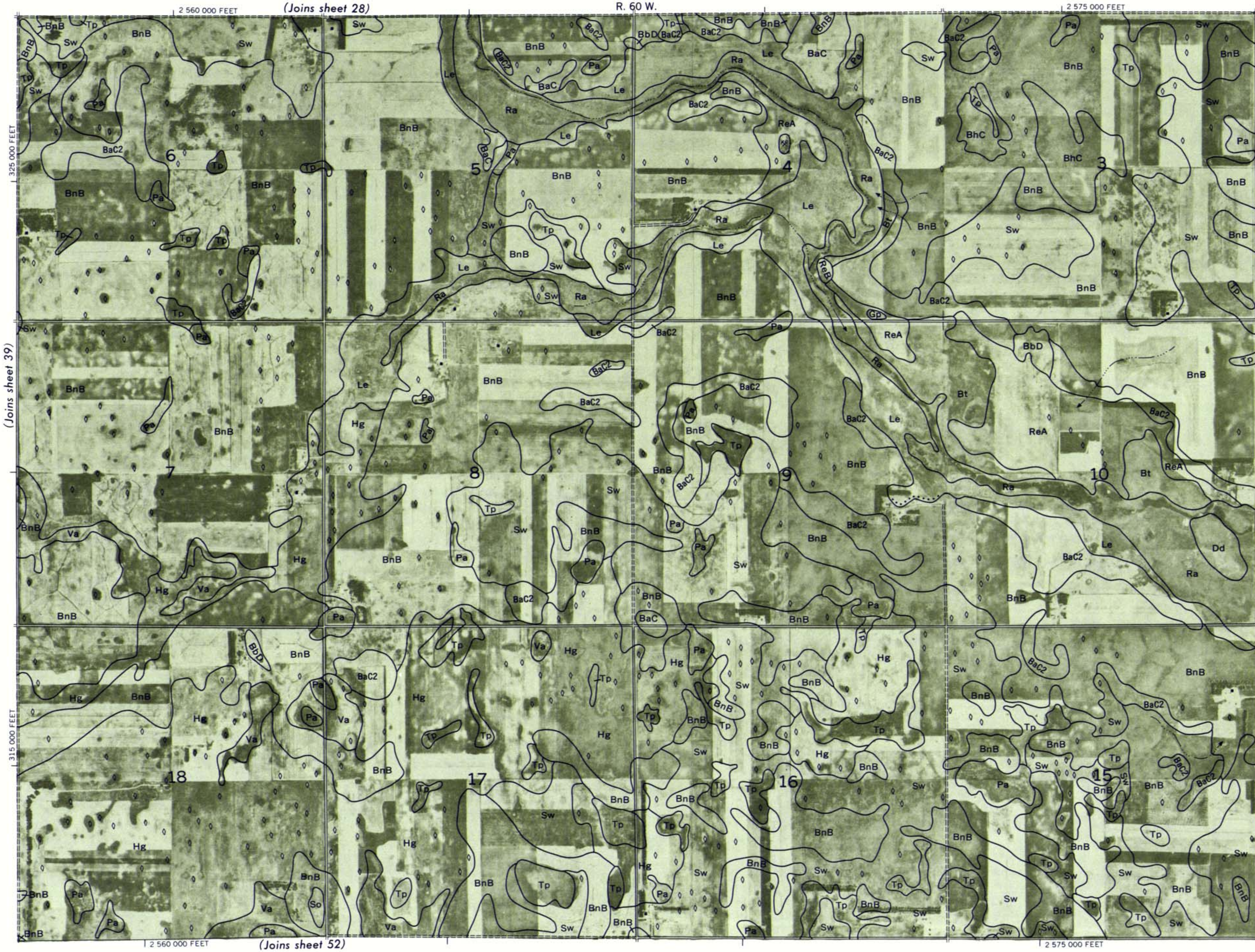
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Ag[redacted]tural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 40

N

1 Mile
5000 Feet
0
Scale 1:20 000
1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 40

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

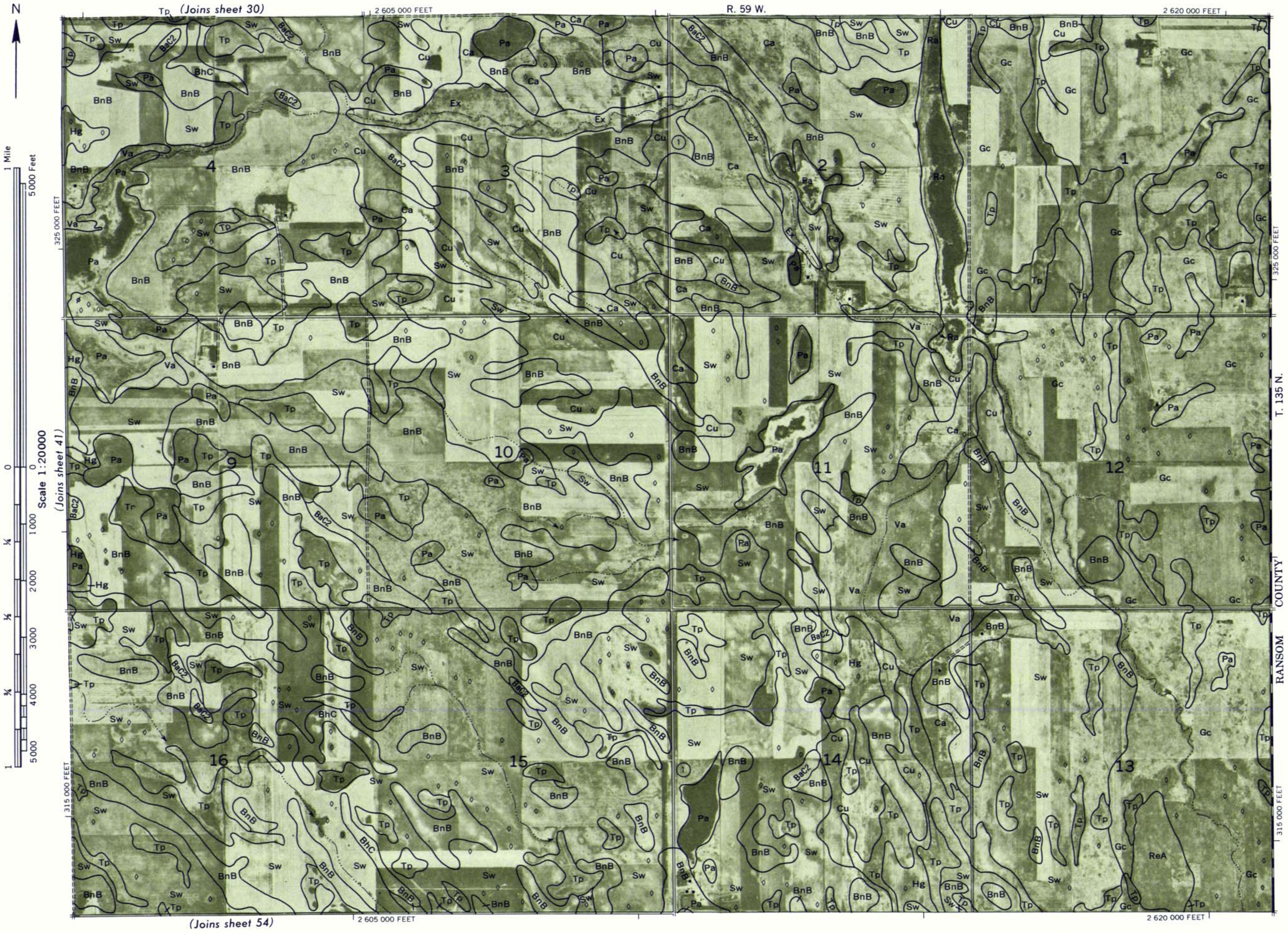
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 41

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 42



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system south zone. Mosaic compiled from 1964 aerial photographs.

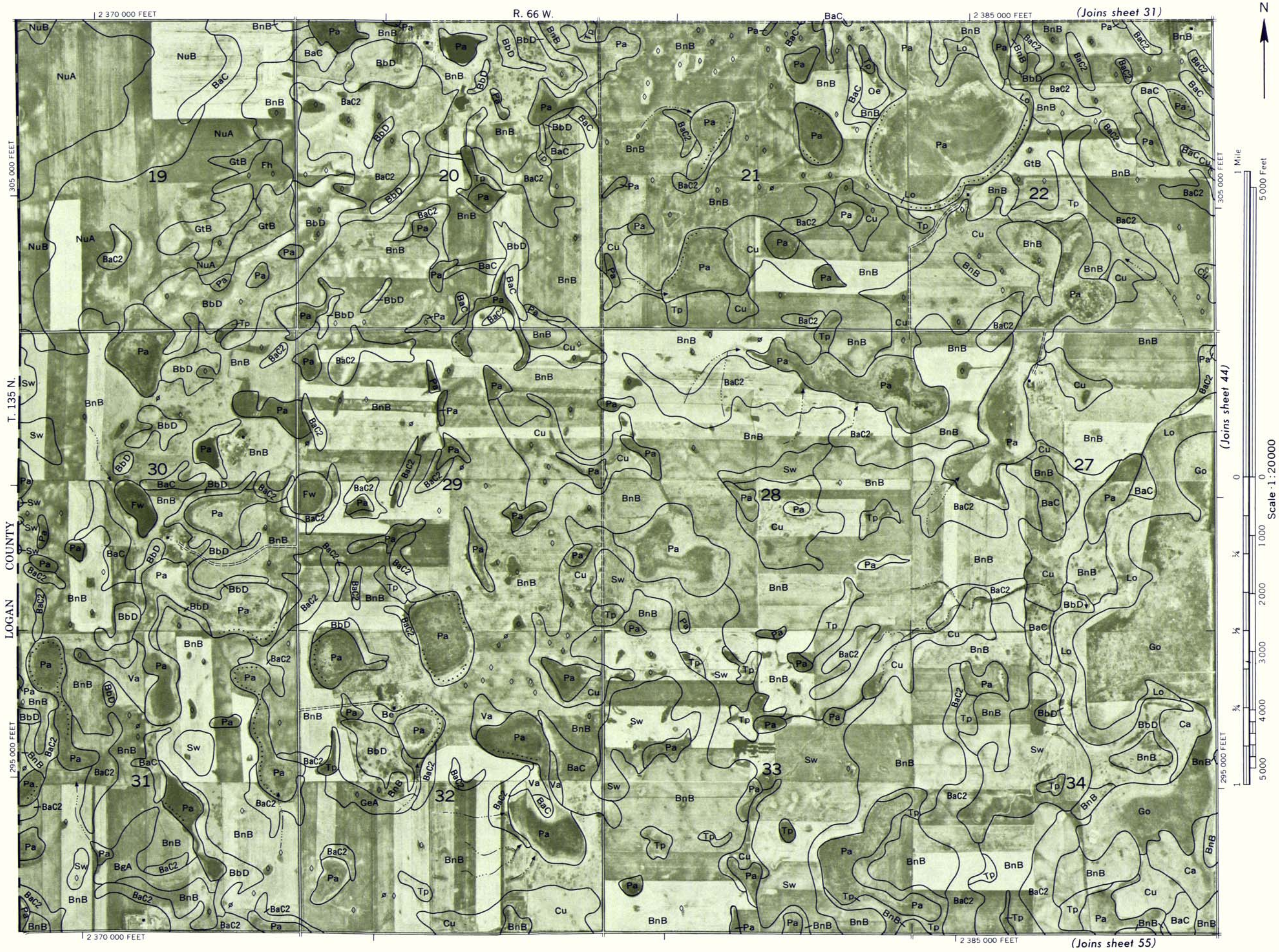
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 42

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

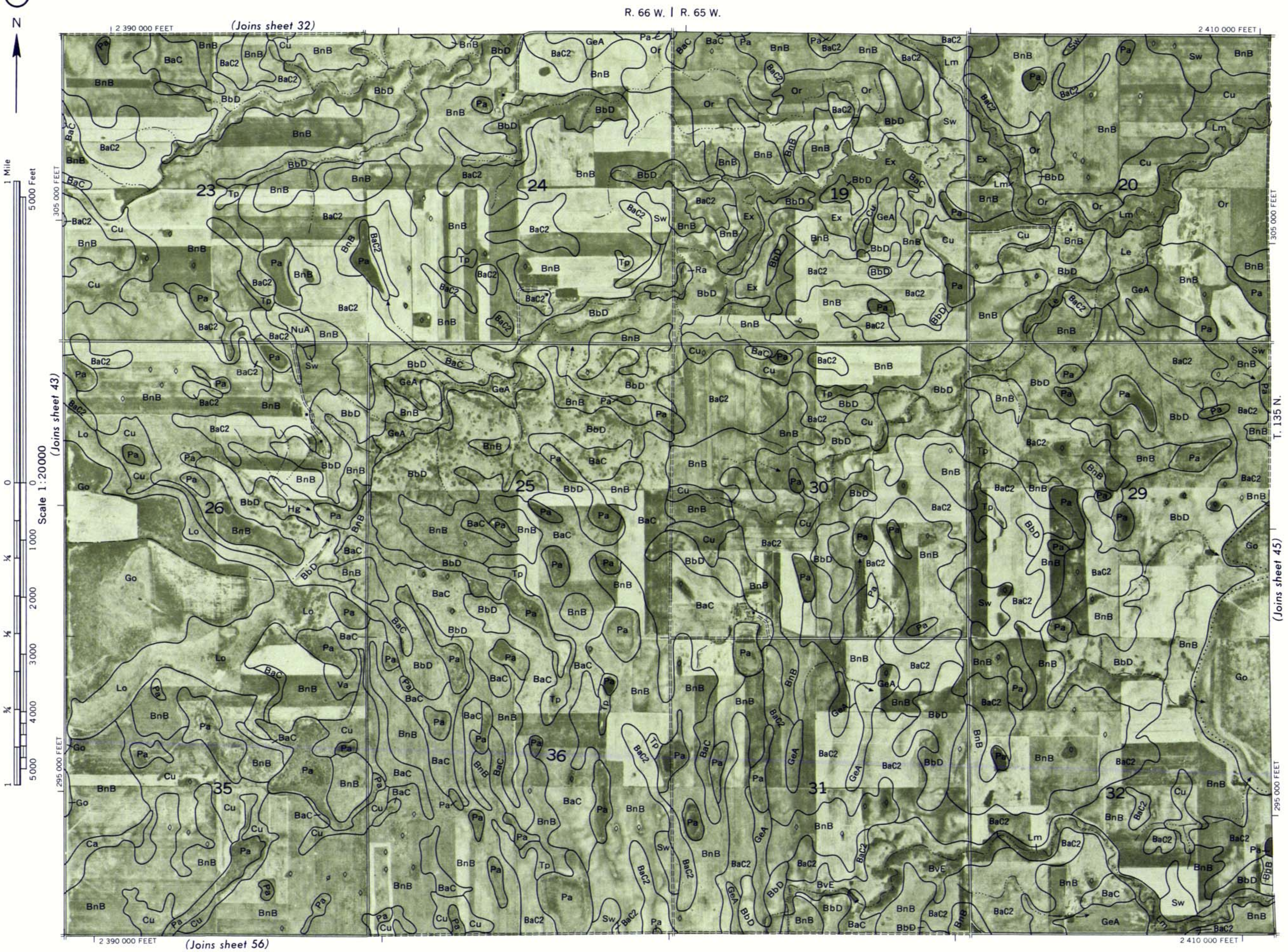
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 43



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 44



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

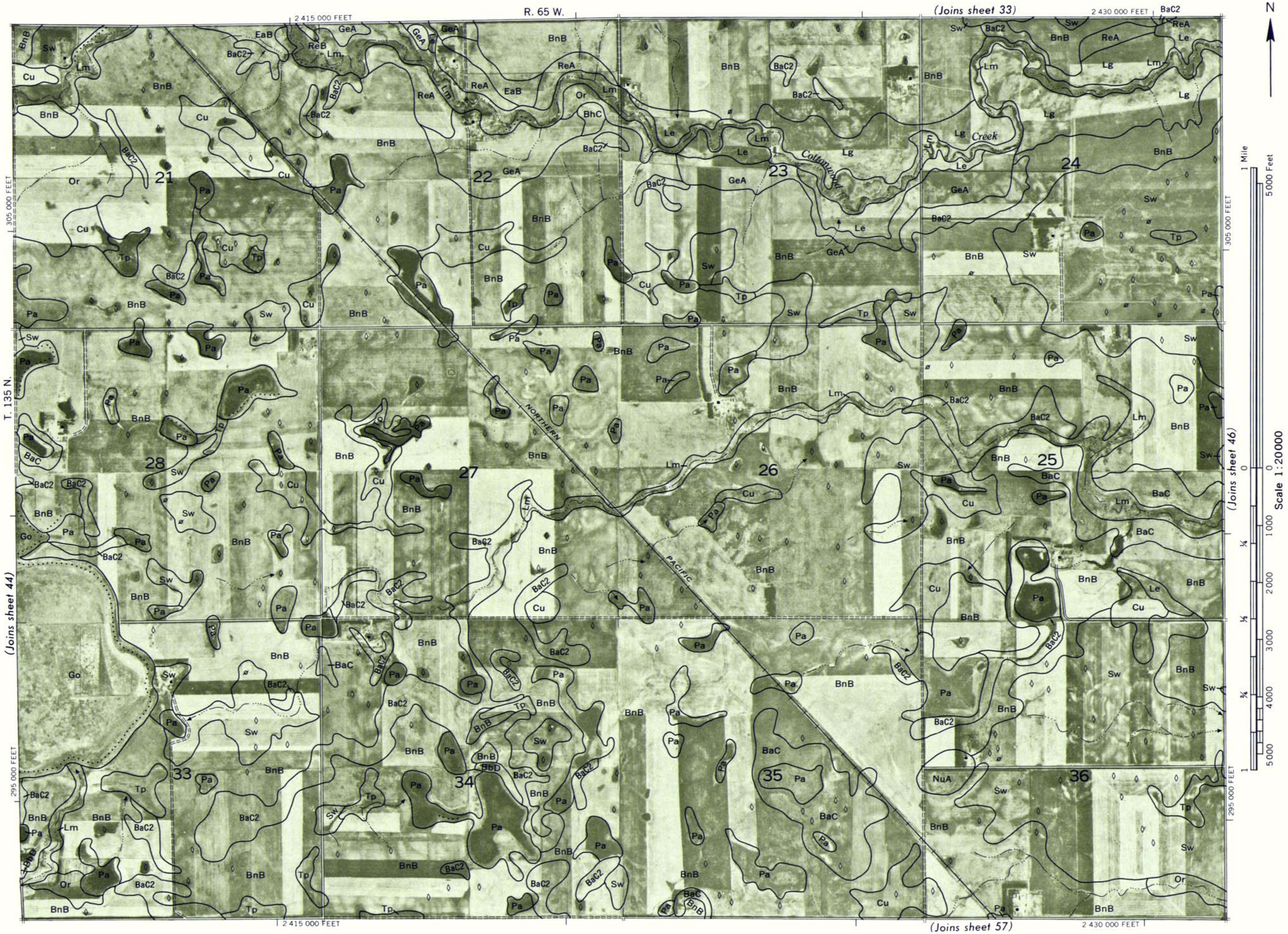
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 44

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

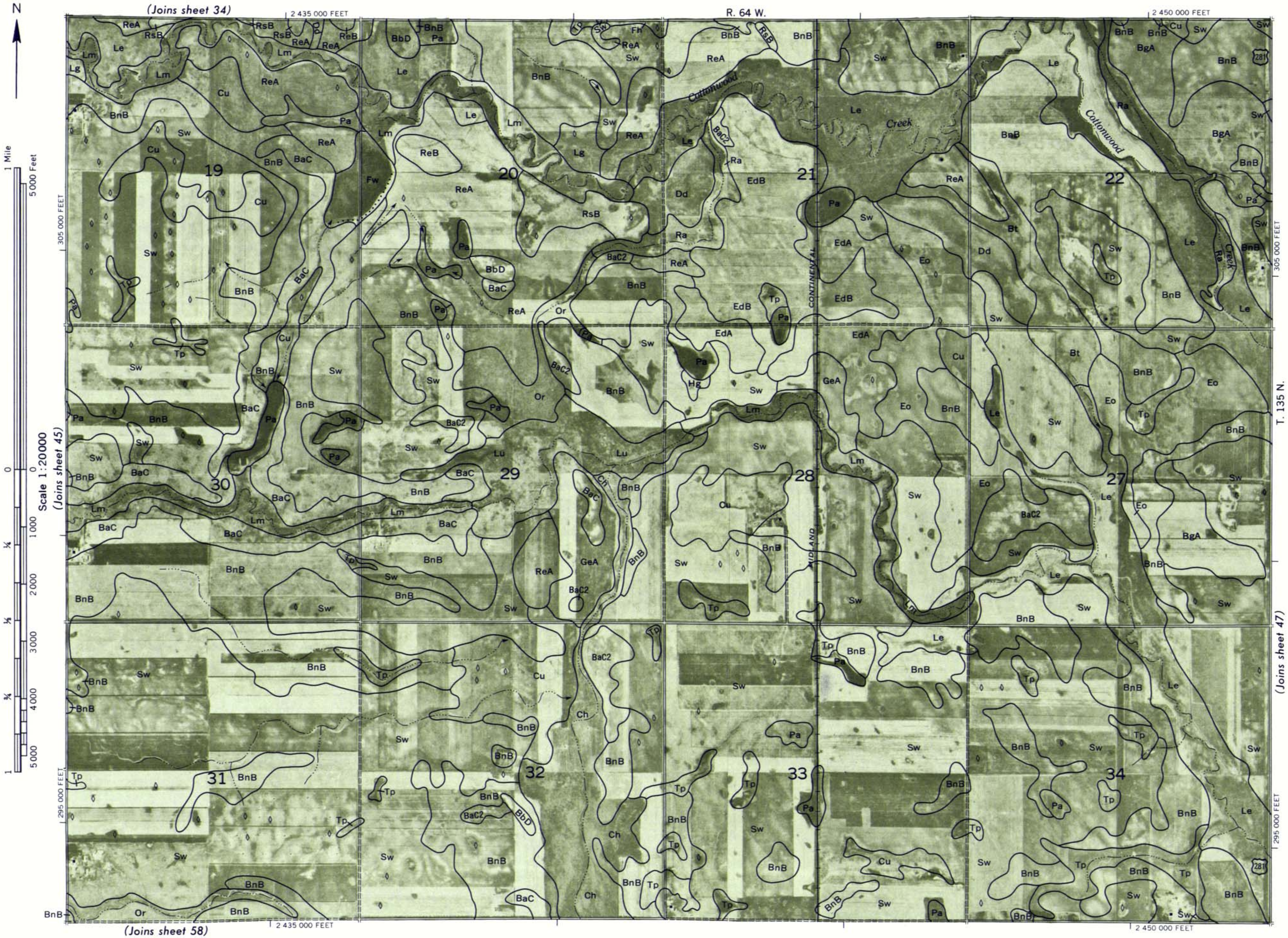
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 45



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 46

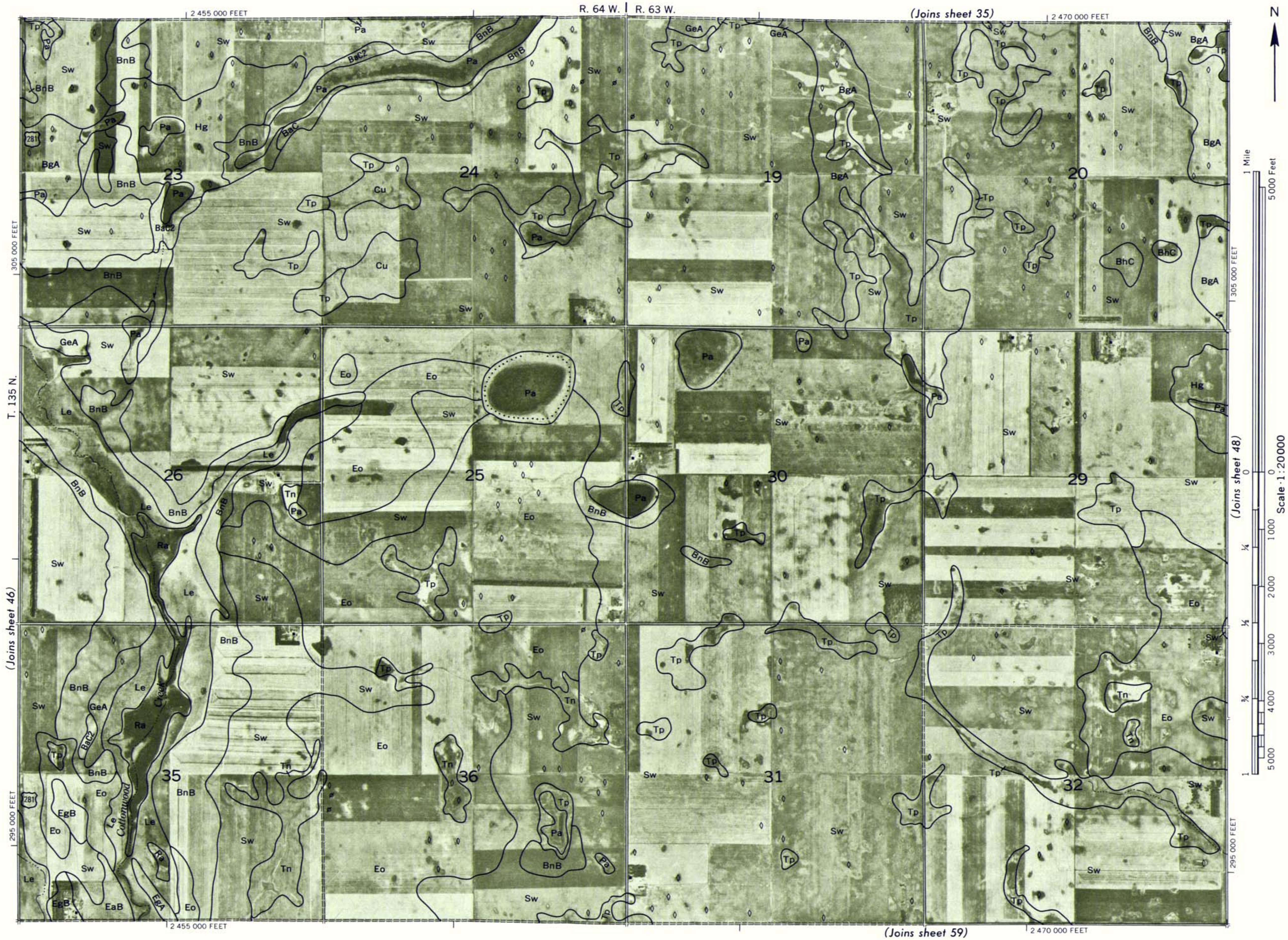


Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 46

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system, 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station. Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 47

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 48

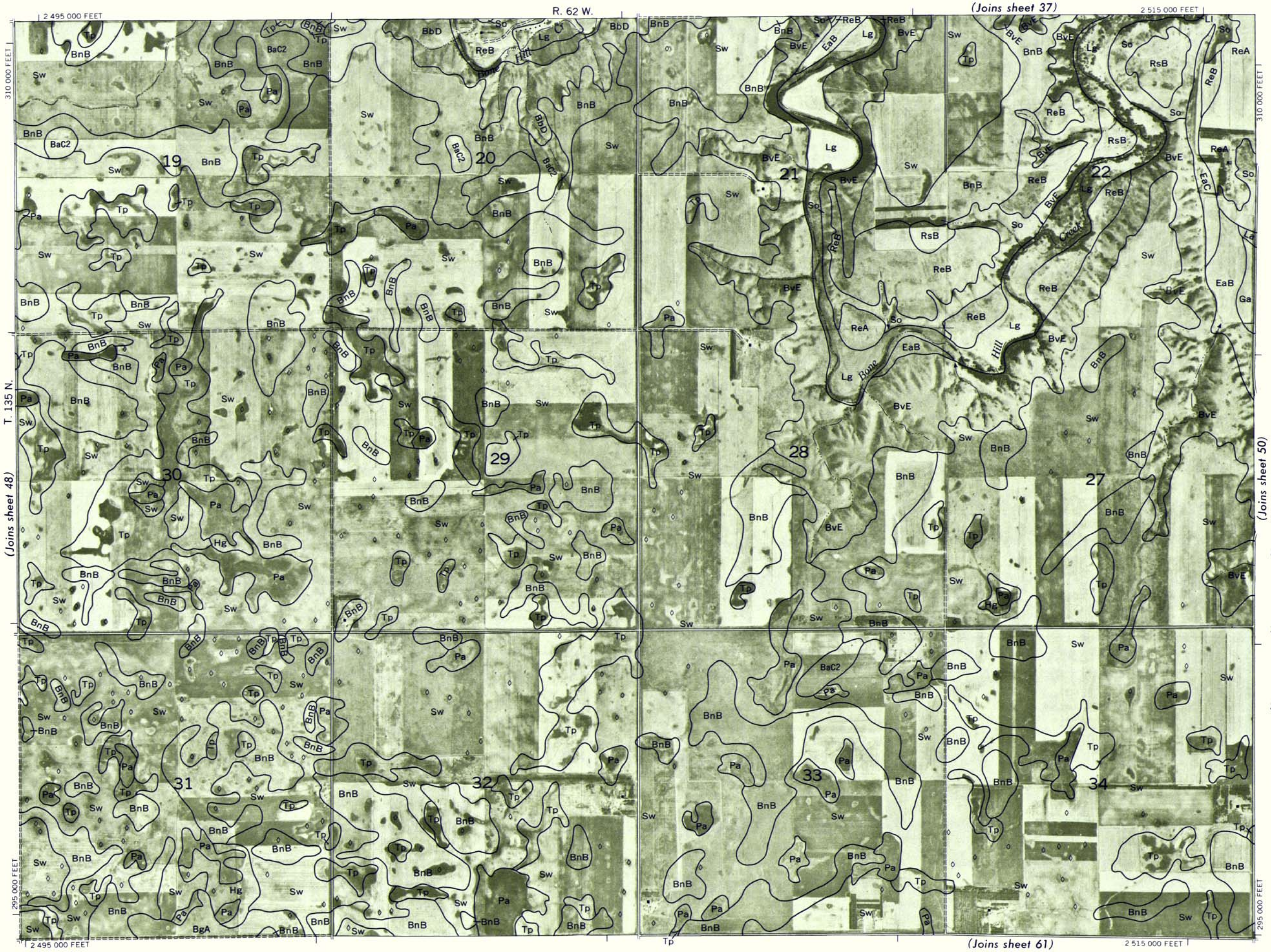
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 48

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

N

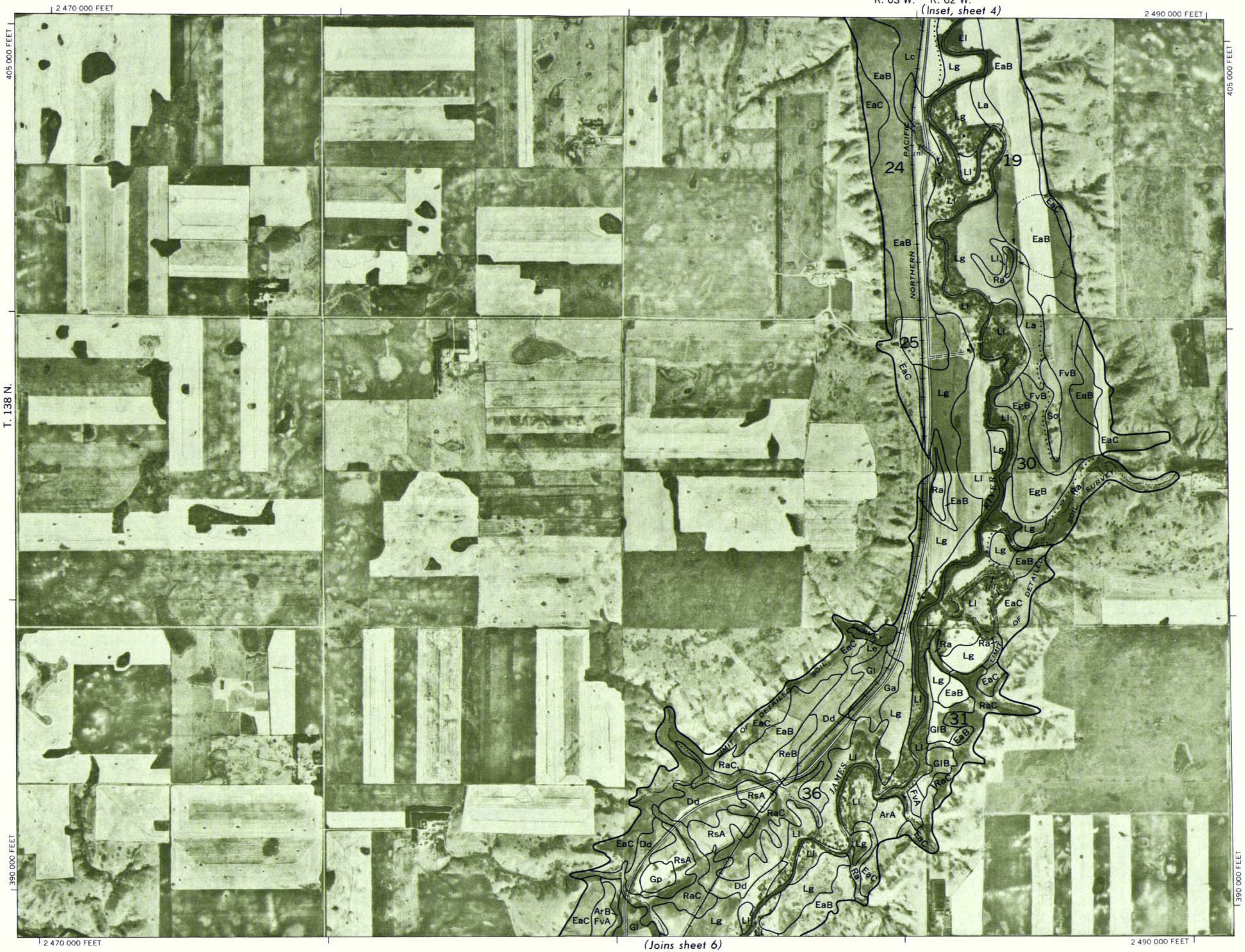


1 Mile
5000 Feet
0
0
1000
¼
2000
½
3000
¾
4000
5000
1
Scale 1:20000

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

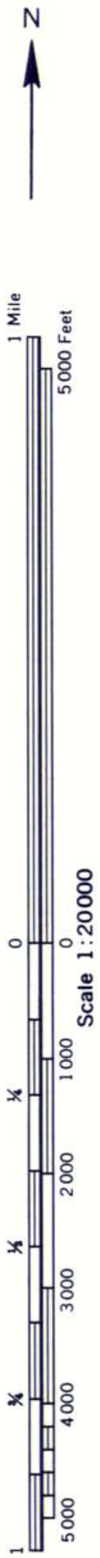
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 50



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

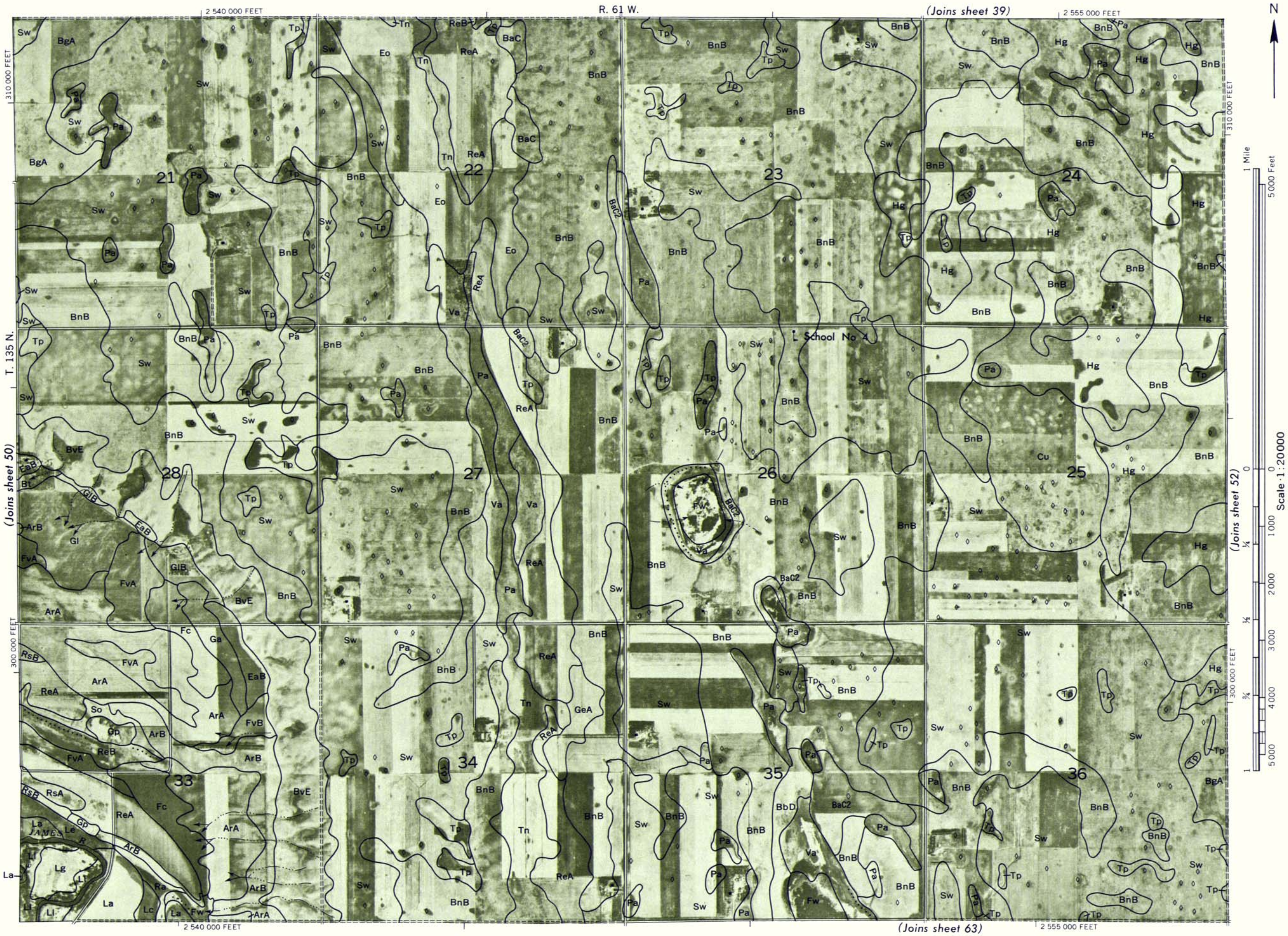
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY NORTH DAKOTA NO. 50

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

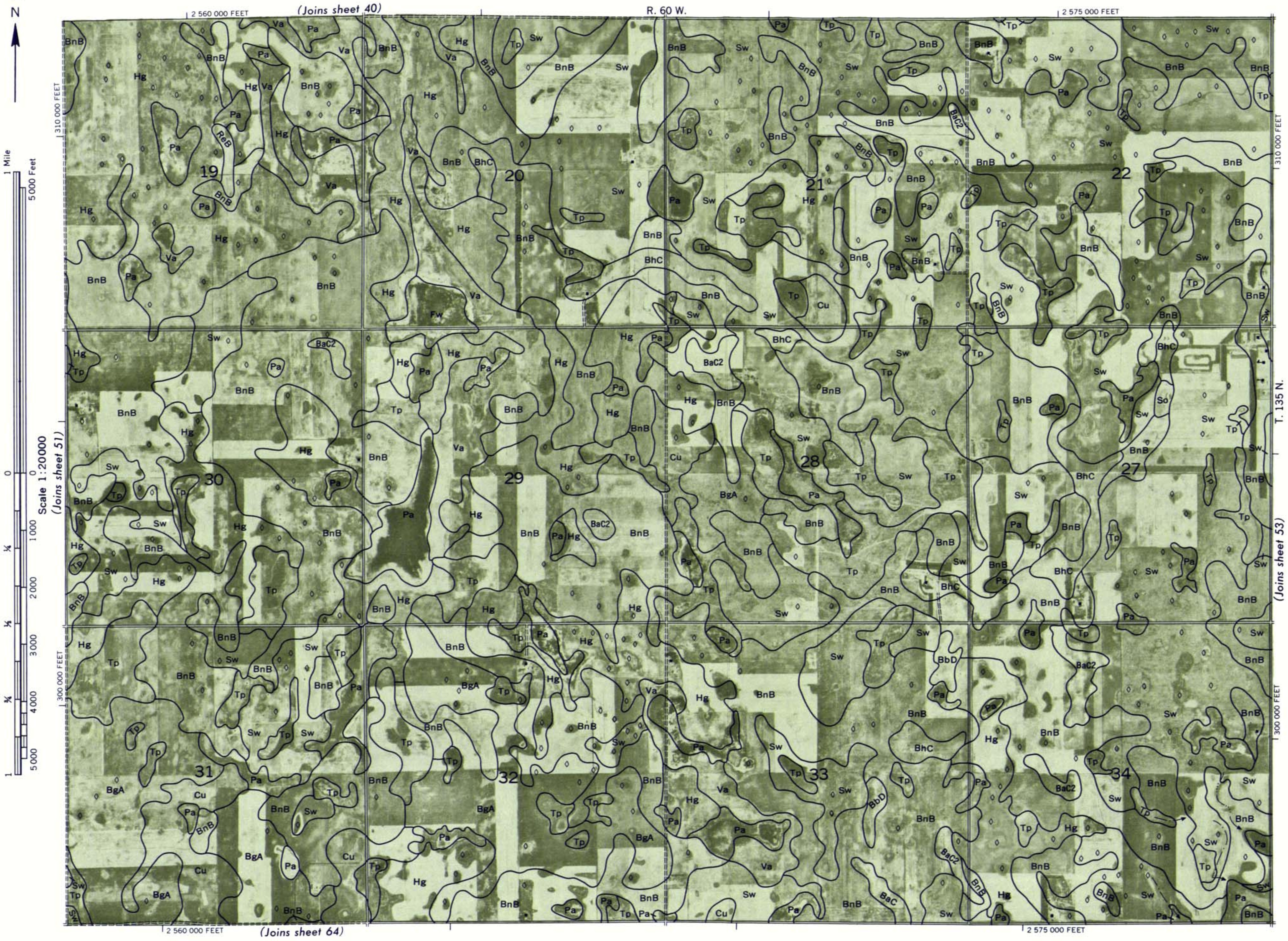
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 51



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 52



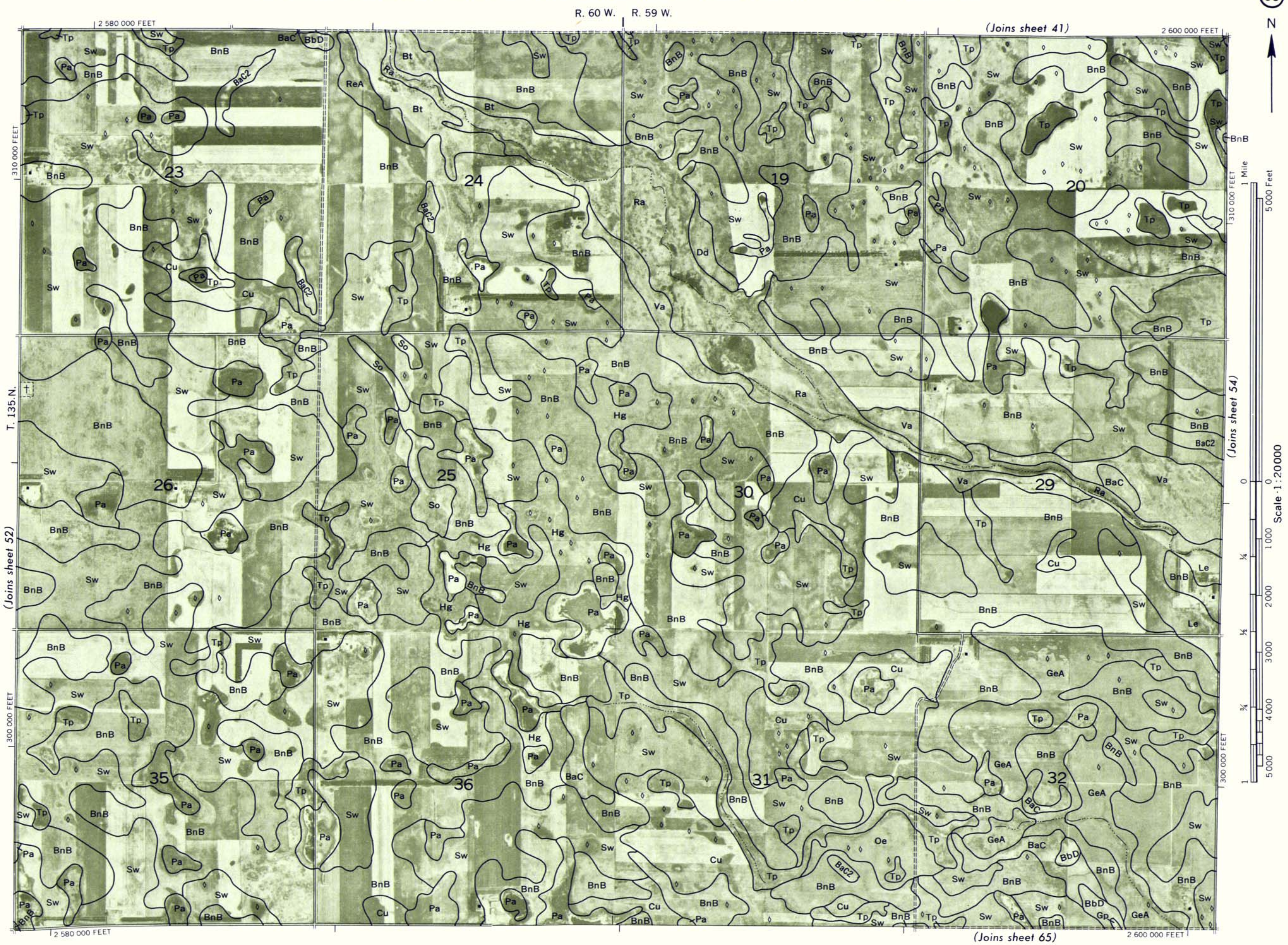
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 52

Land division corners are approximately positioned on this map.

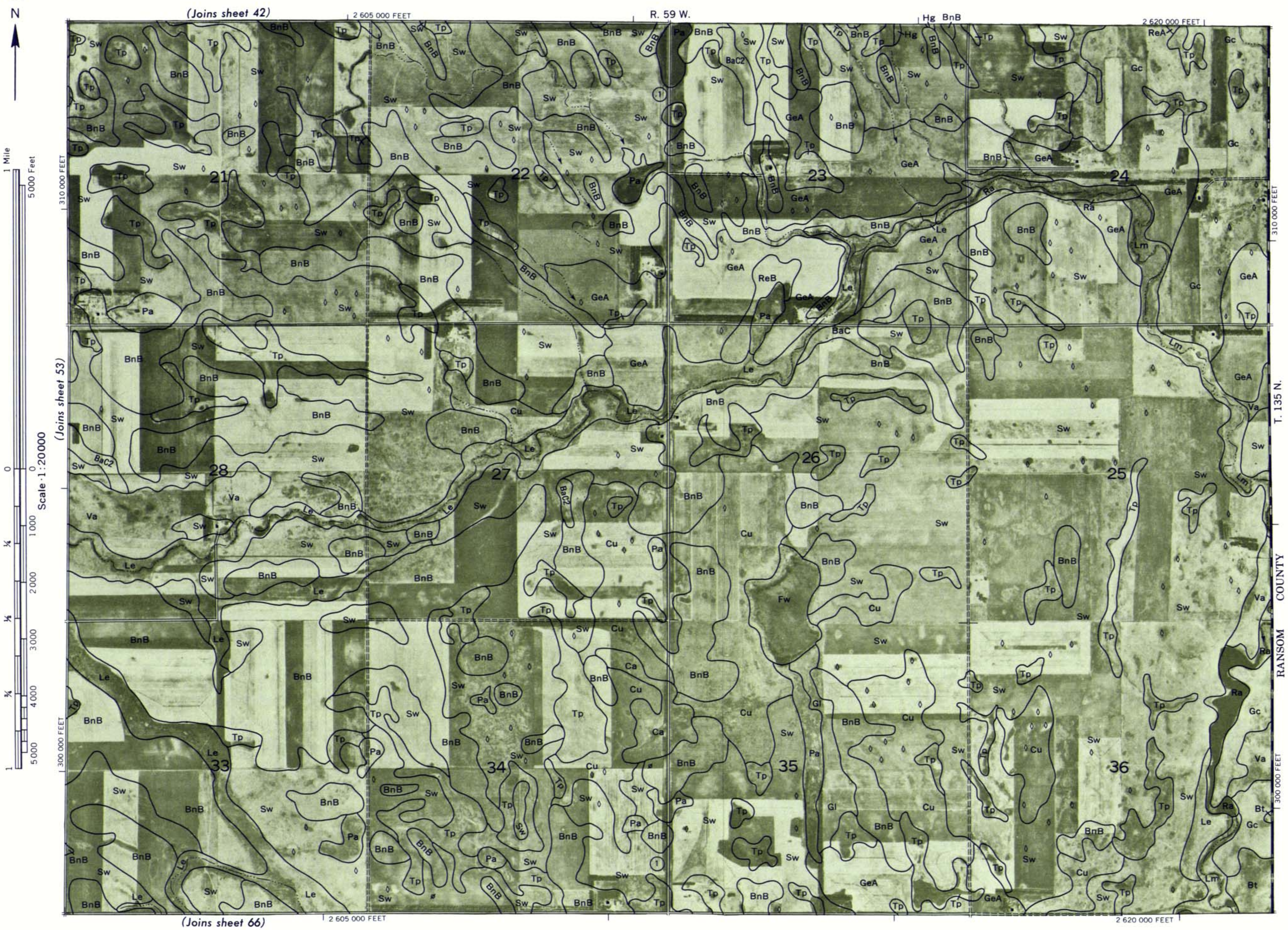
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 54



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 54

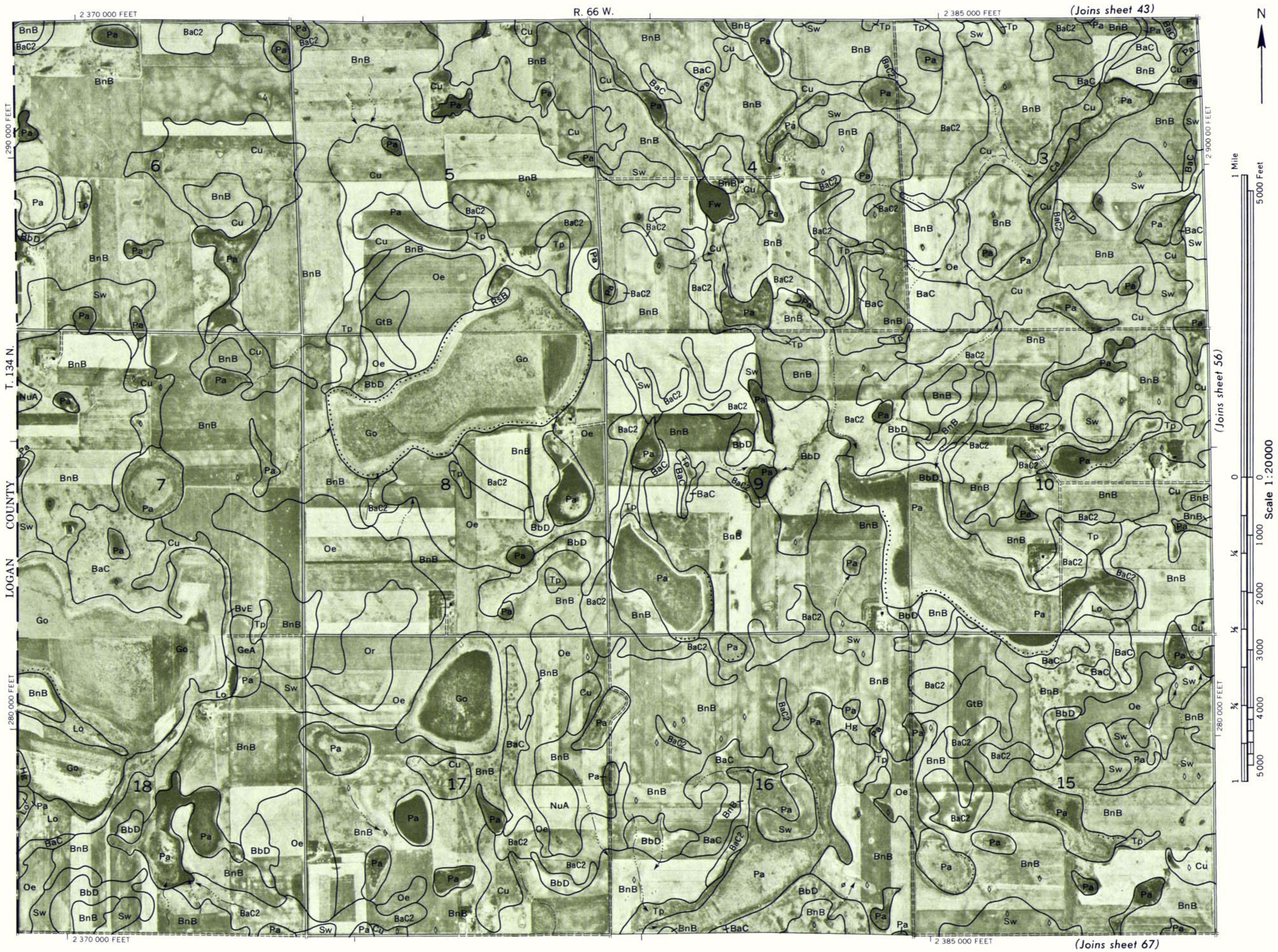
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 55



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

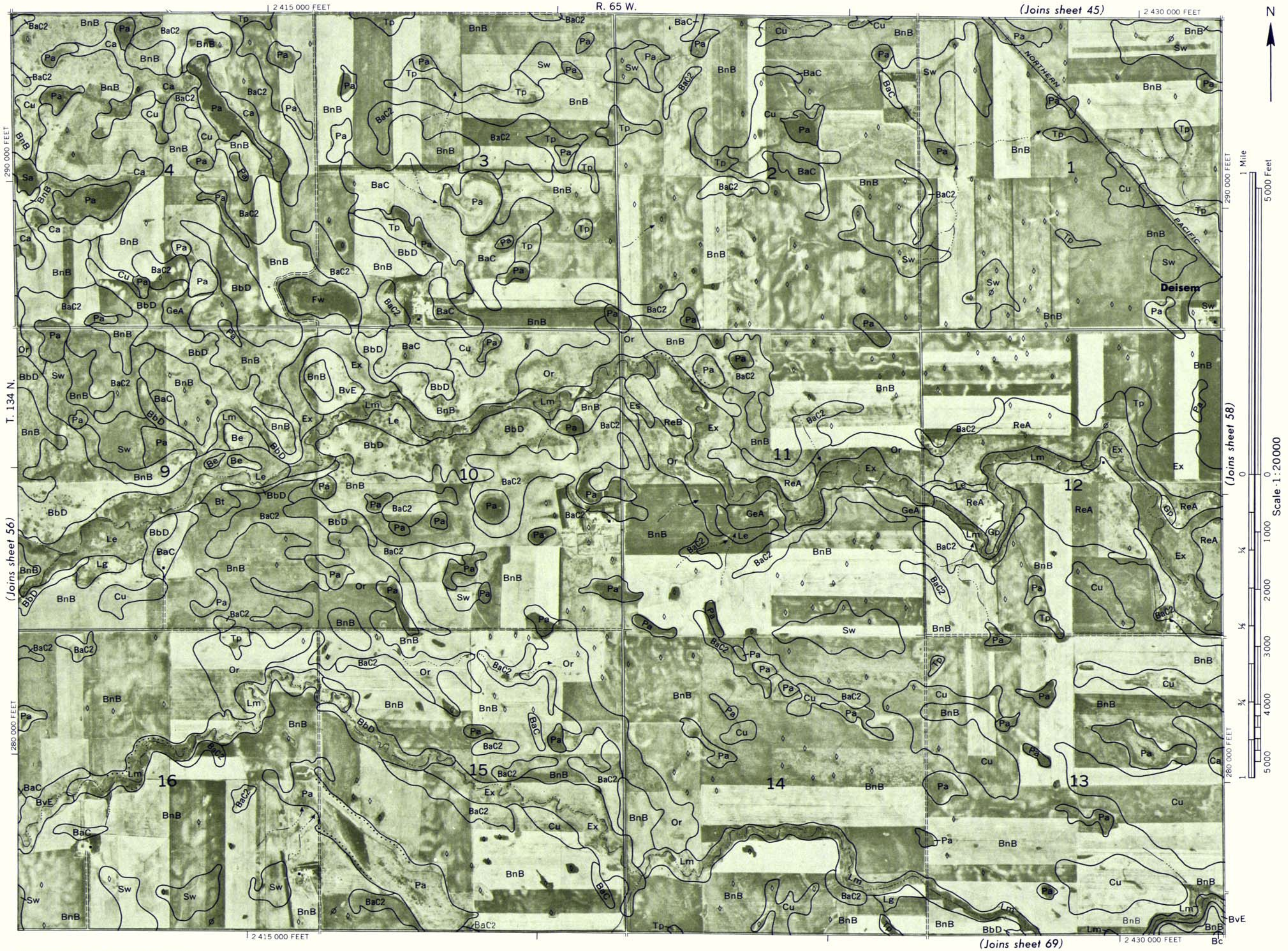
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 56

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system,
south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 56

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



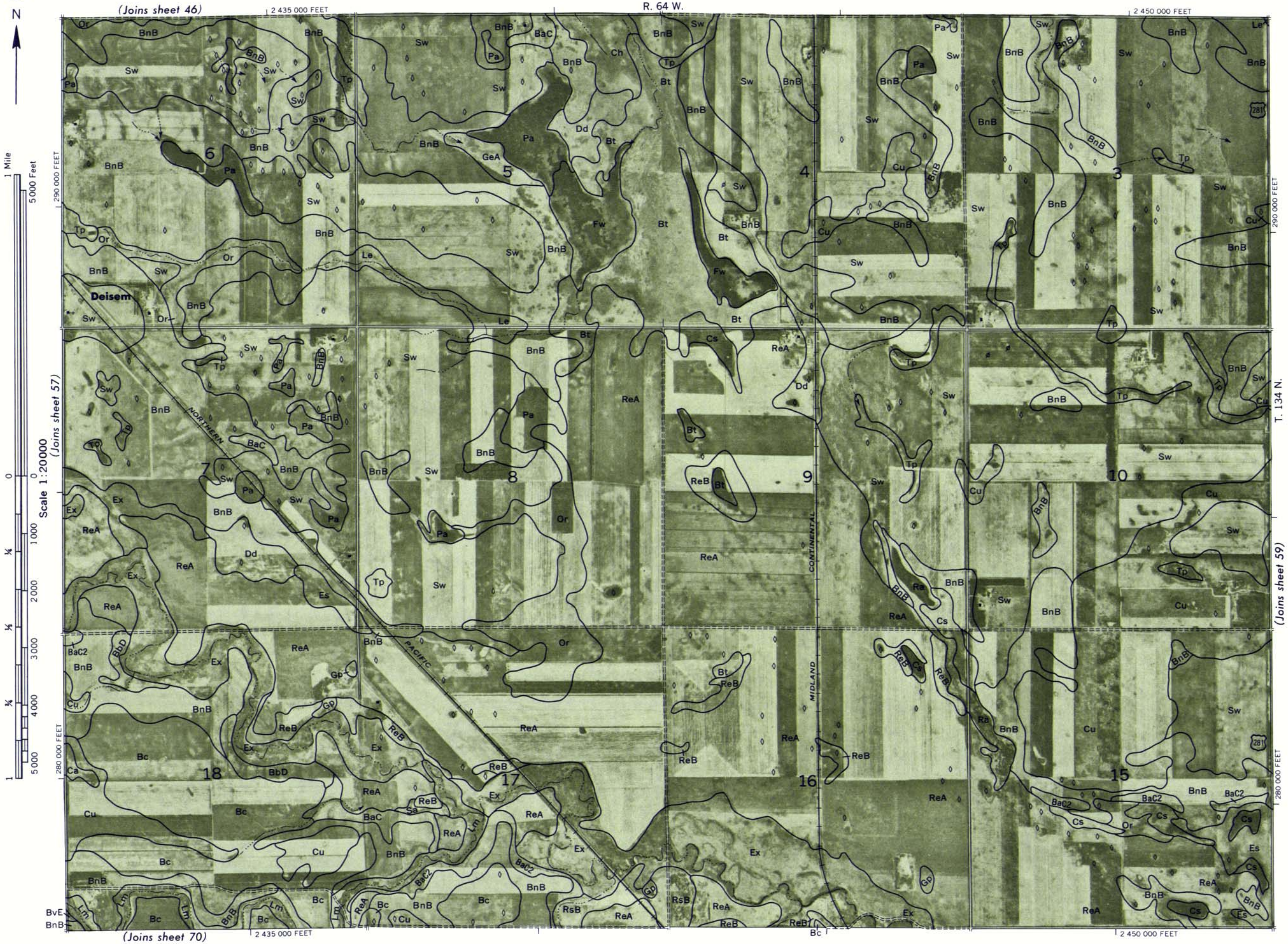
Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 57

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 58



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

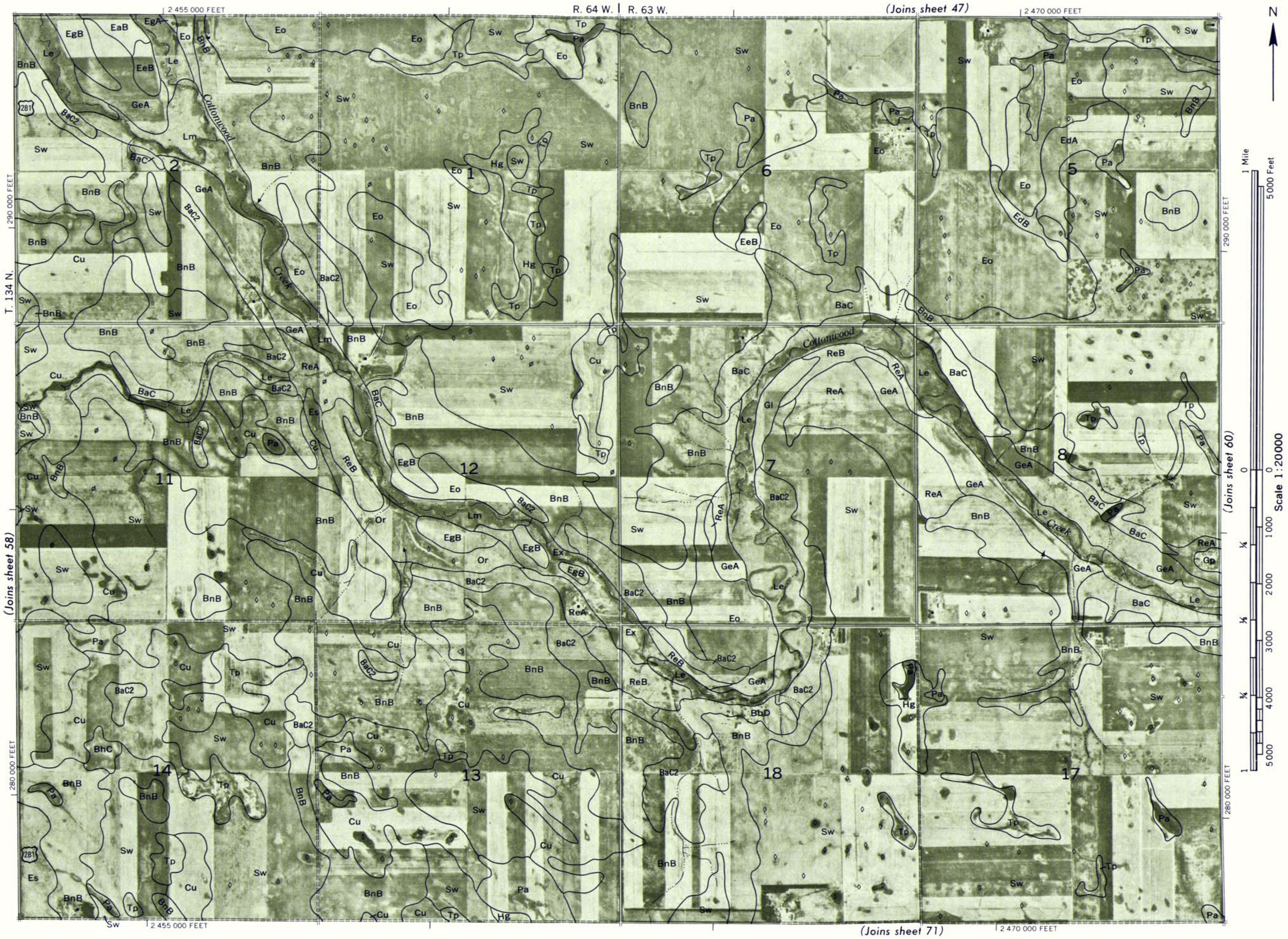
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 58

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 59



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 6

N

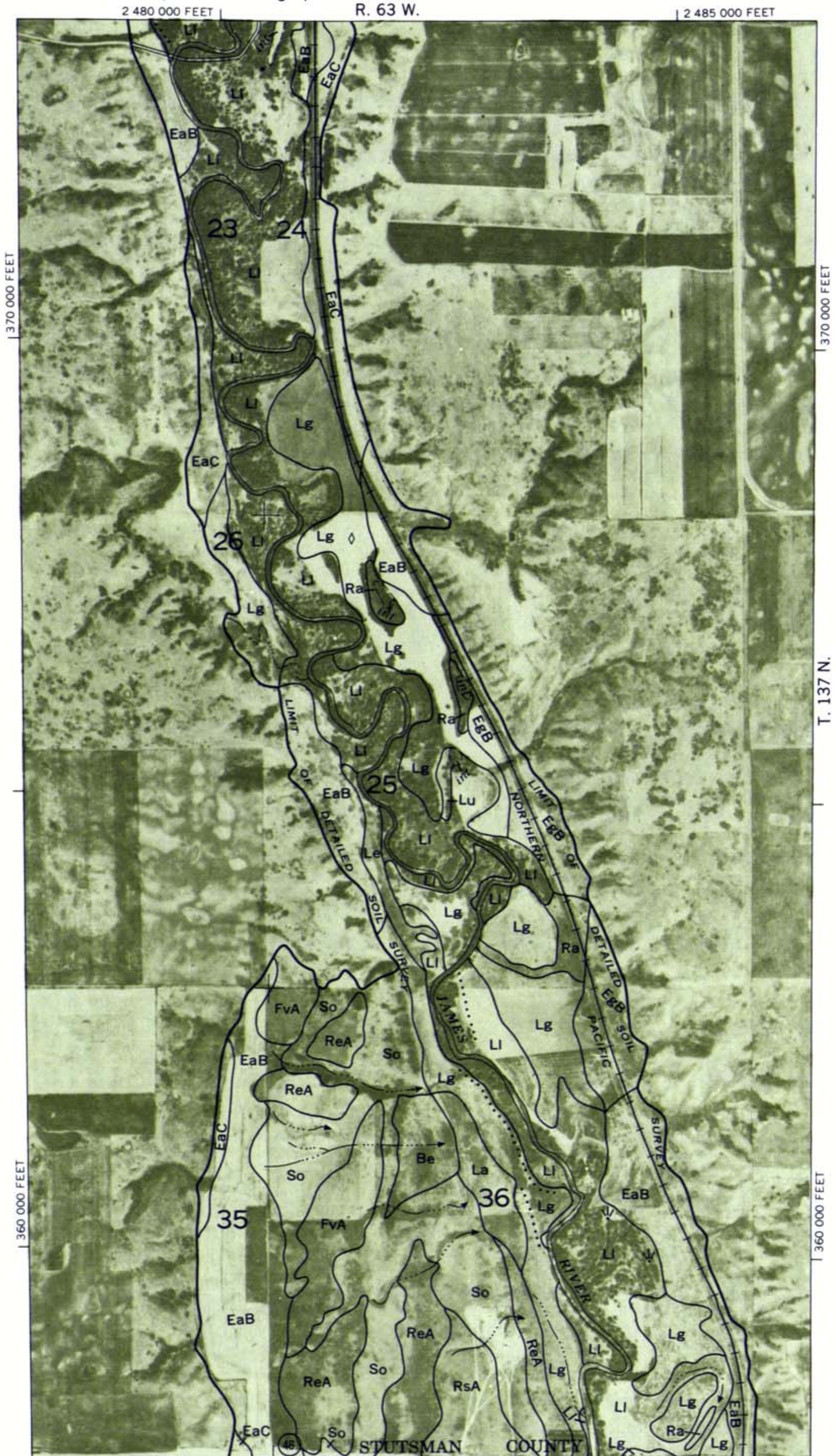
Scale 1:20000

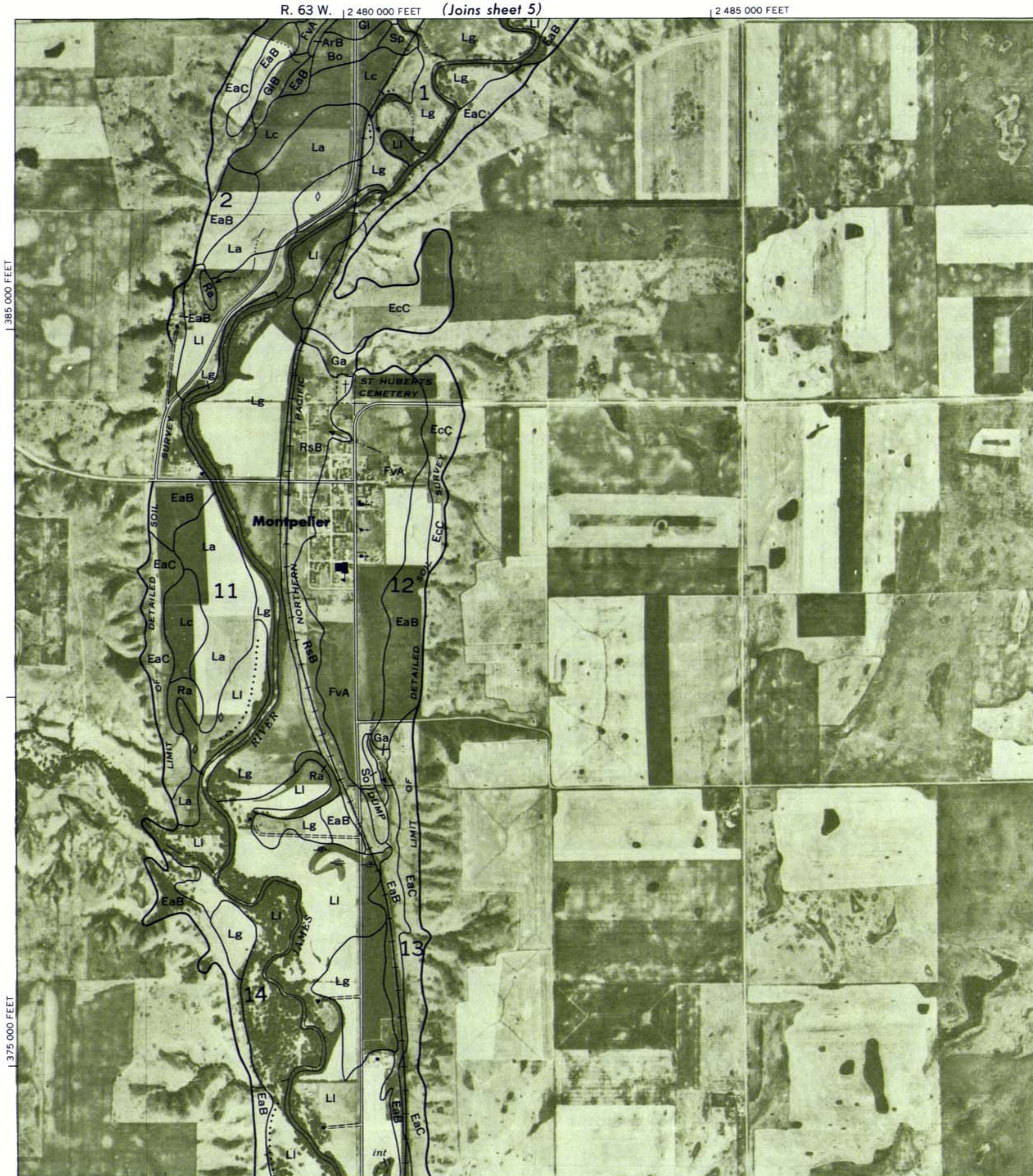
1 Mile

5000 Feet

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1





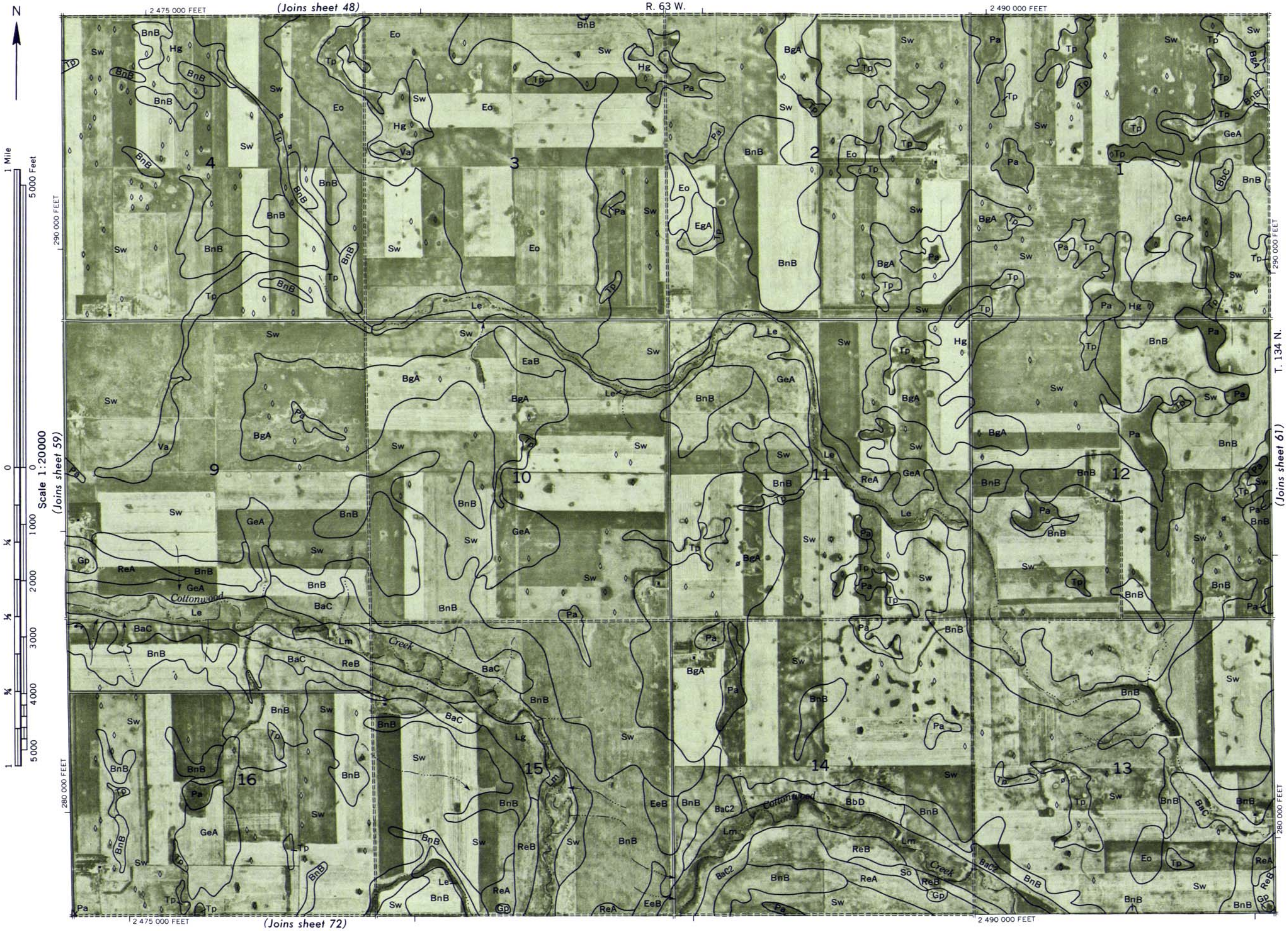
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 6

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 60

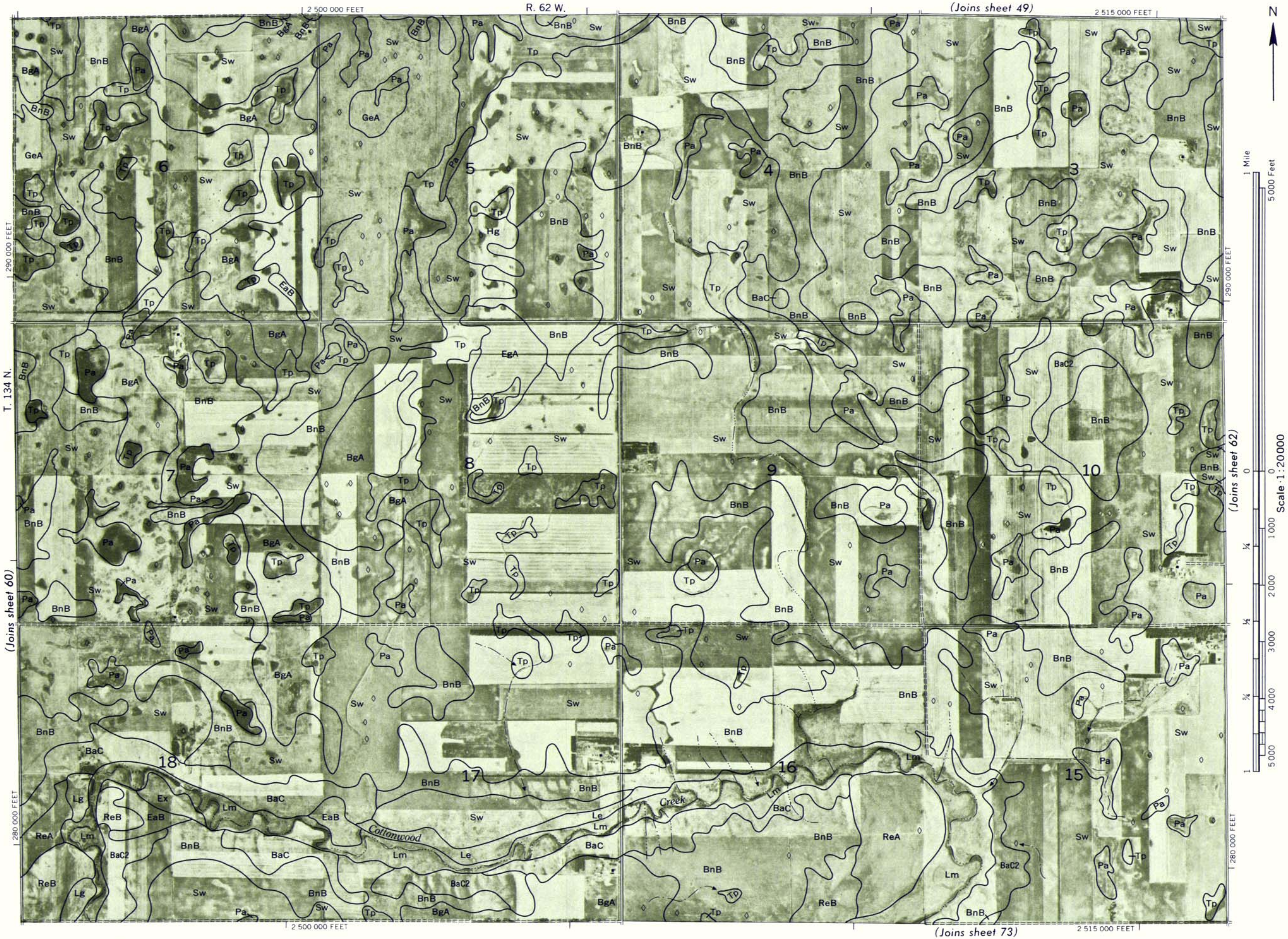


Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 60

Land division corners are approximately positioned on this map.

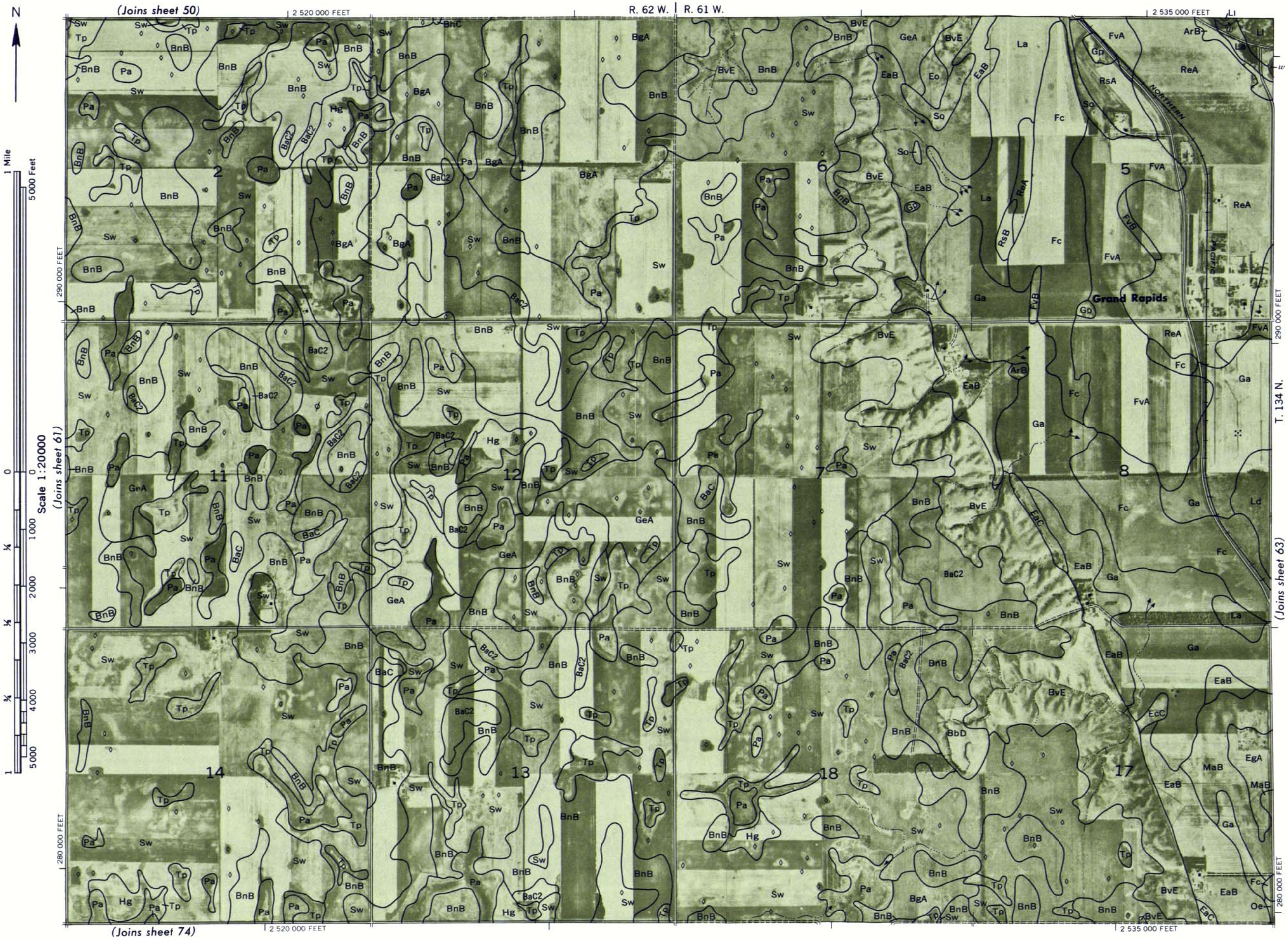
This map is one of a set compiled in 196[illegible] as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 61

This map is one of a set compiled in 196[illegible] as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



LA MOURE COUNTY AND PARTS PF JAMES RIVER VALLEY, NORTH DAKOTA NO. 62

Land division corners are approximately positioned on this map.

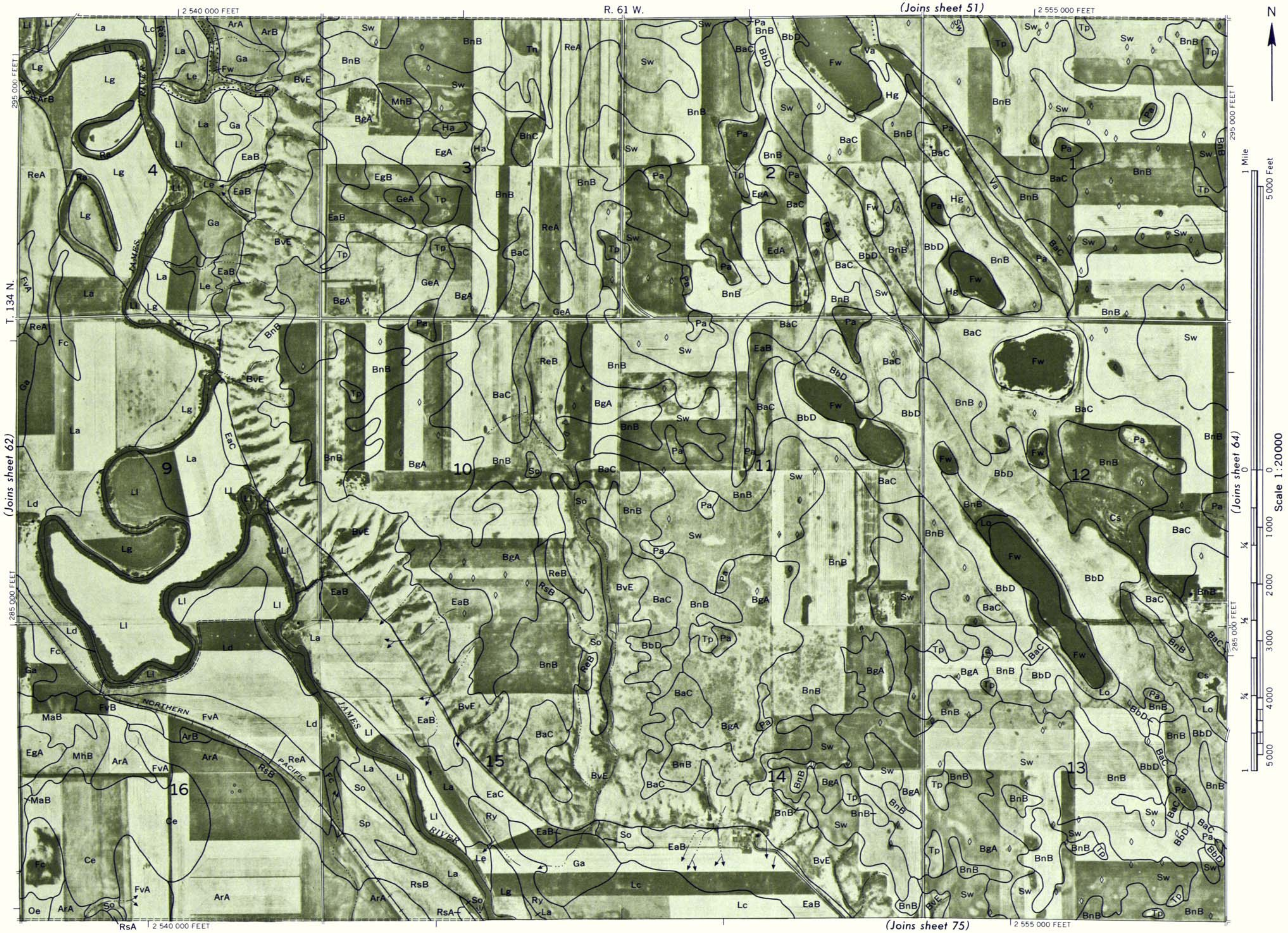
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

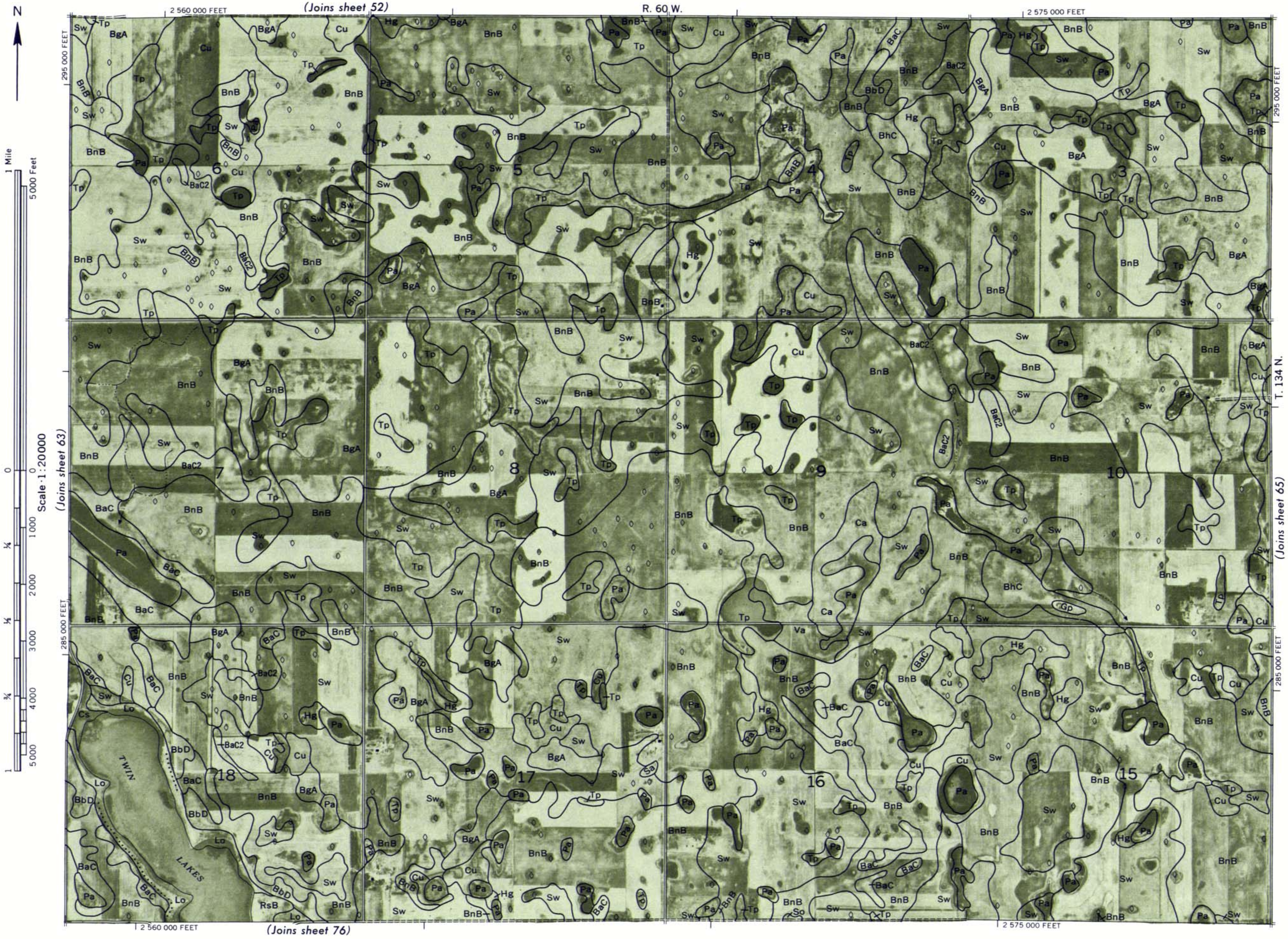
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 63



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 64

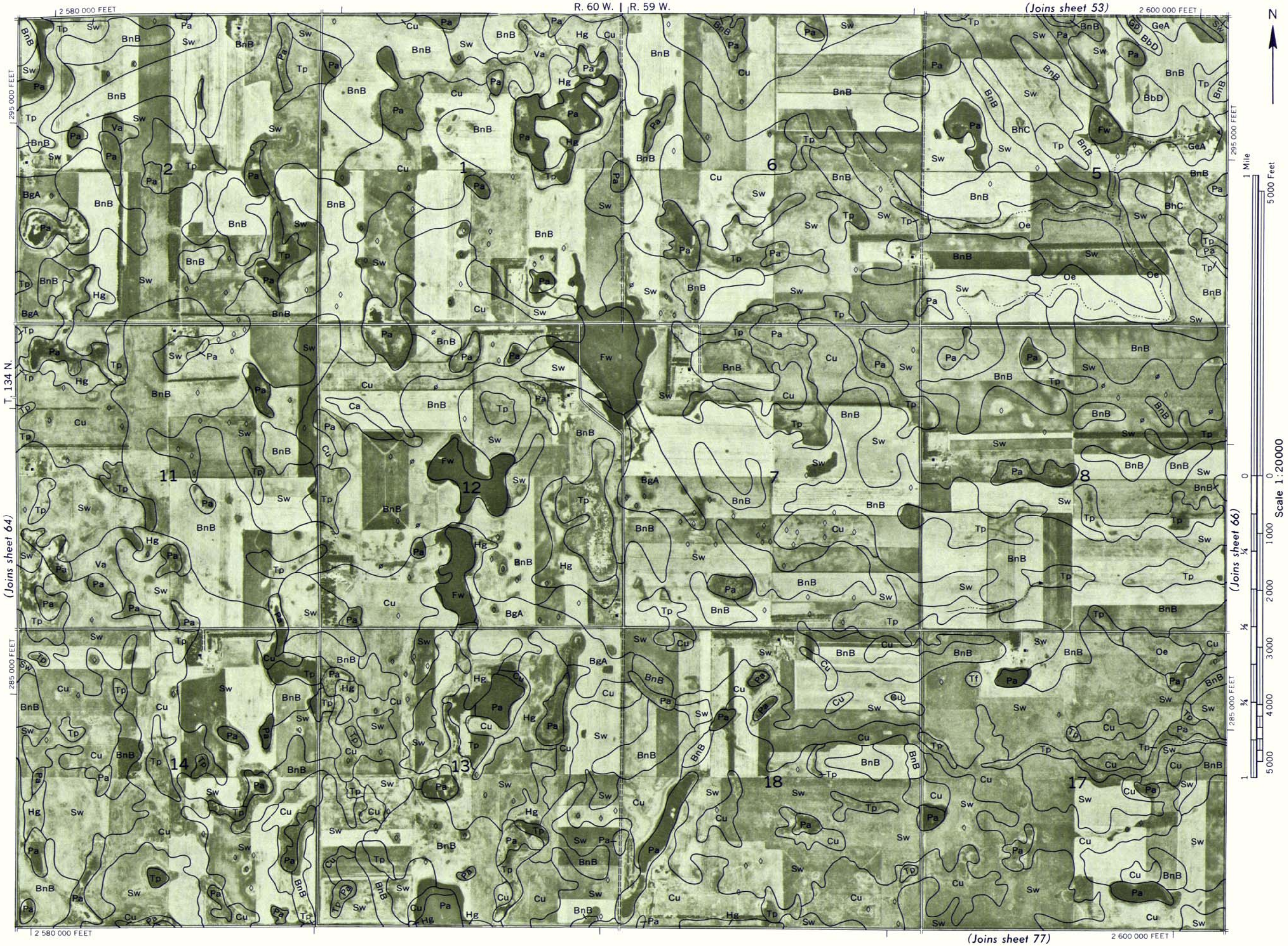


LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 64

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 65

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 66

N

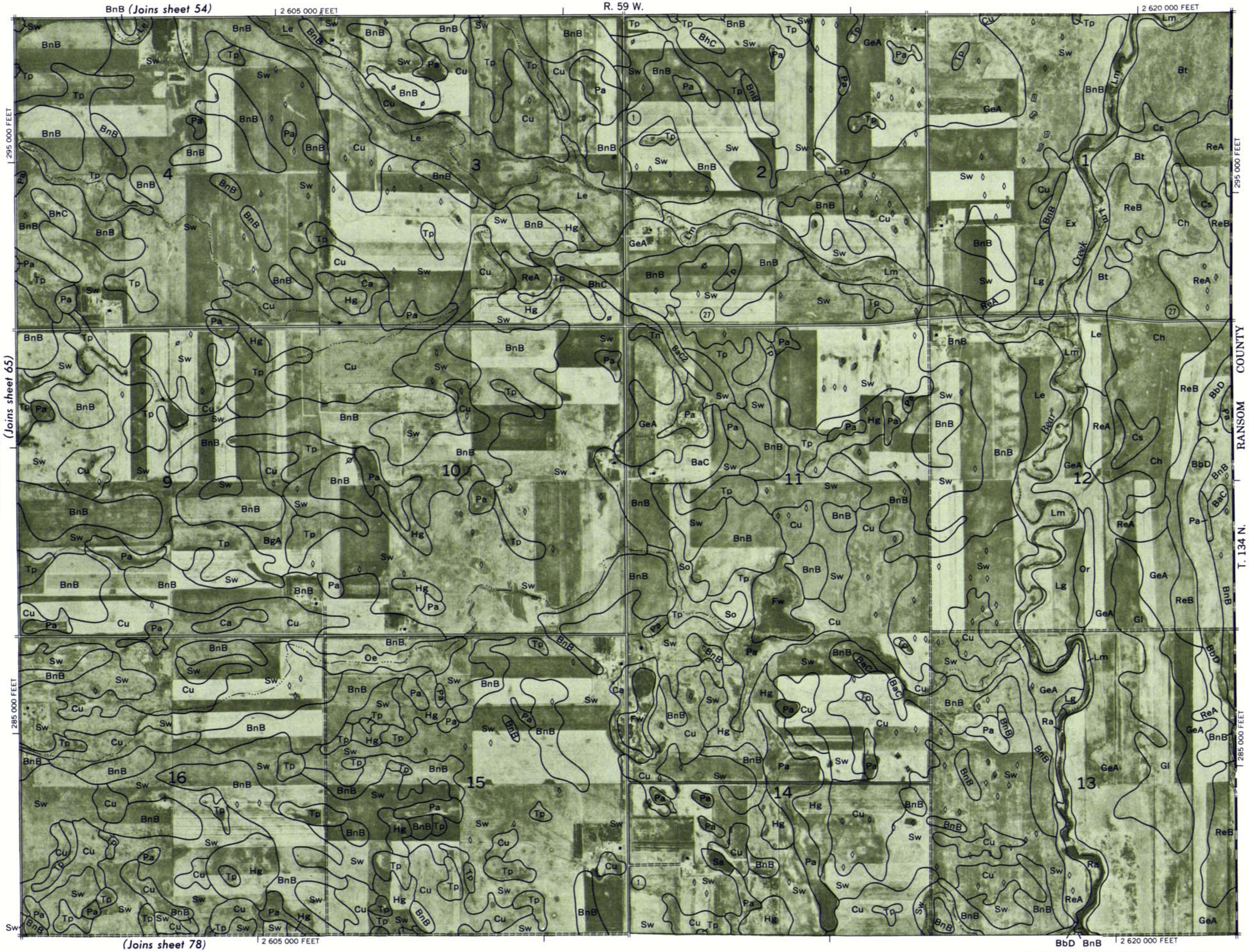
1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000



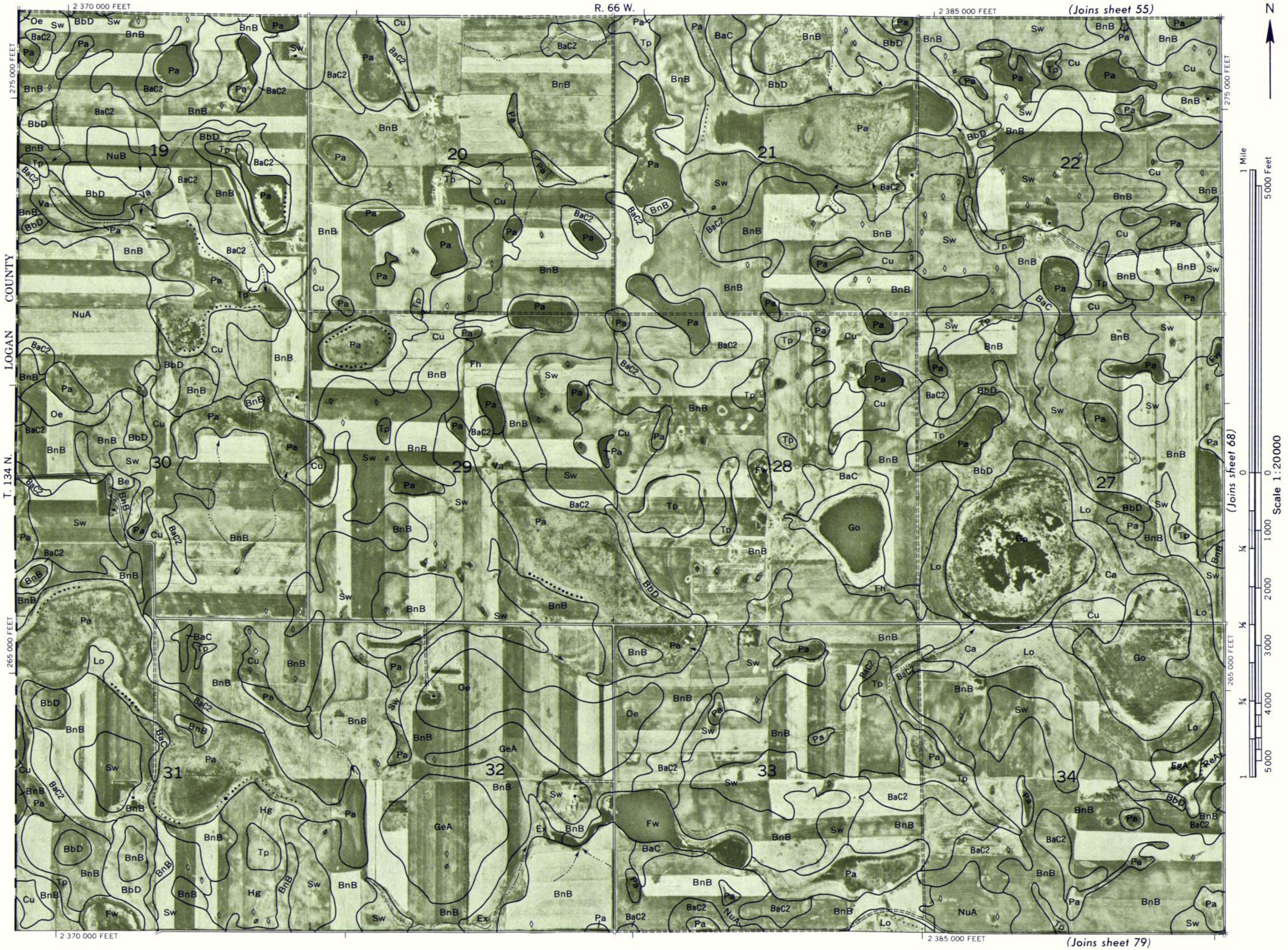
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 66

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 68

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 68

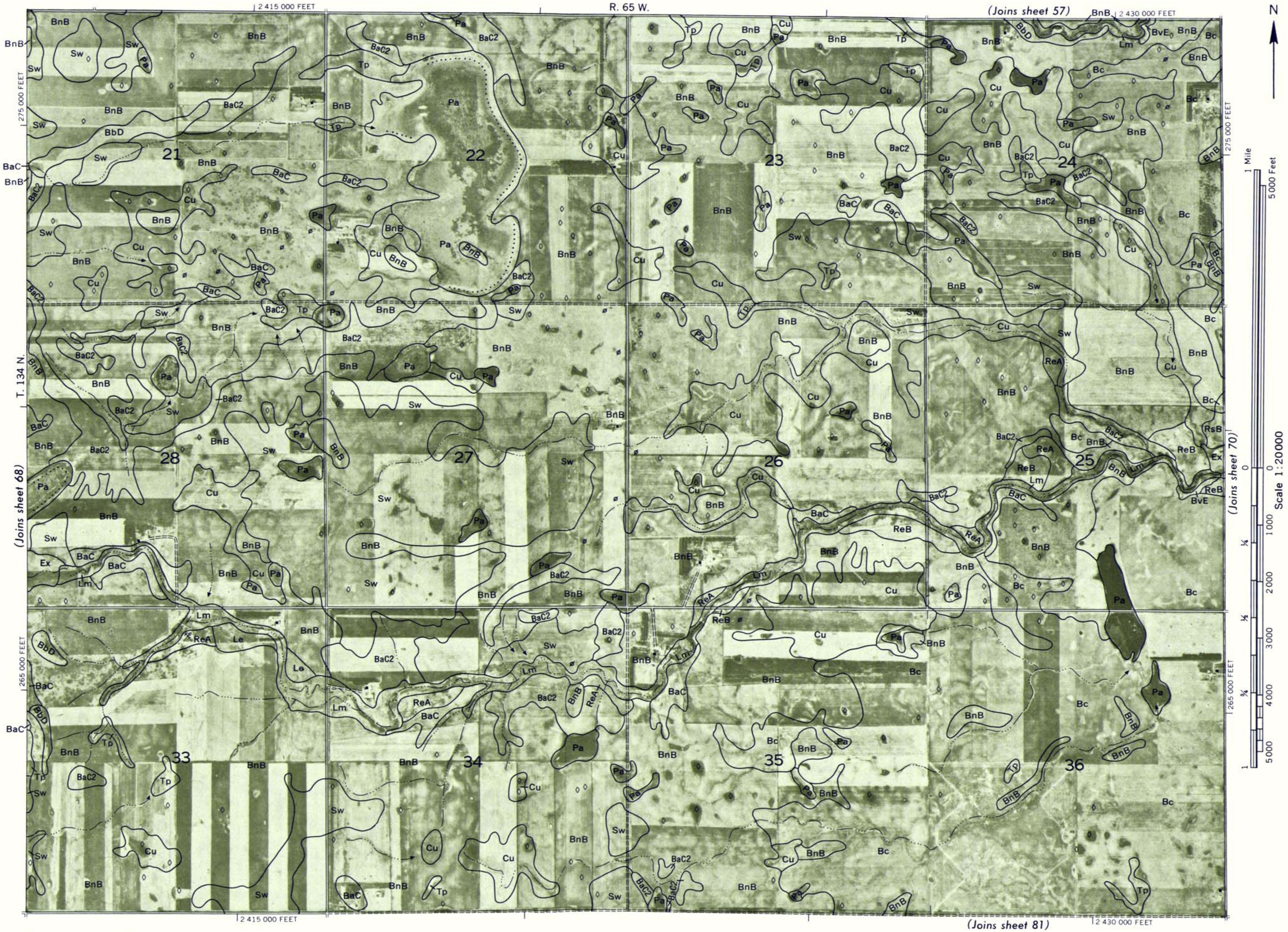
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 69

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

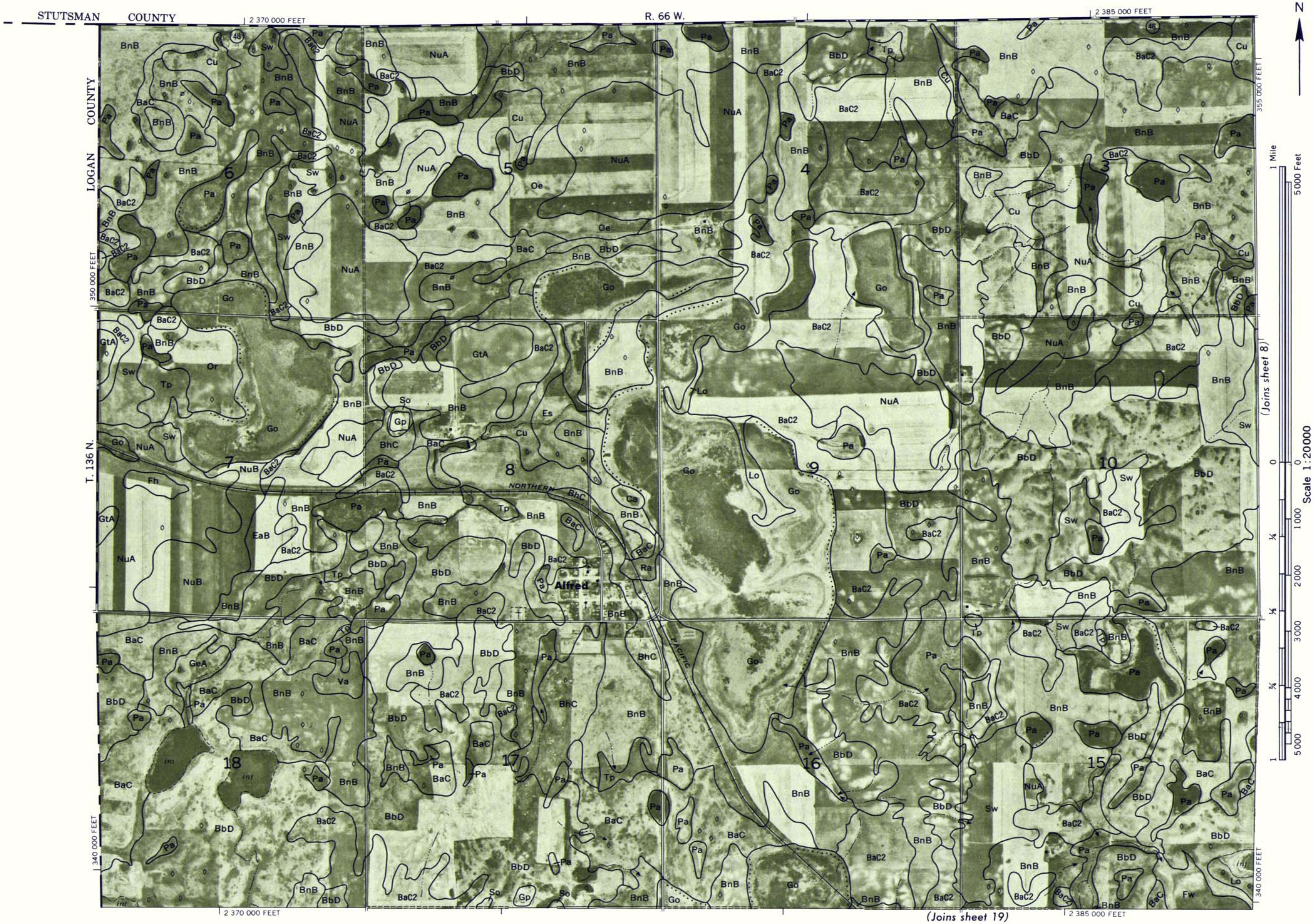
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 69



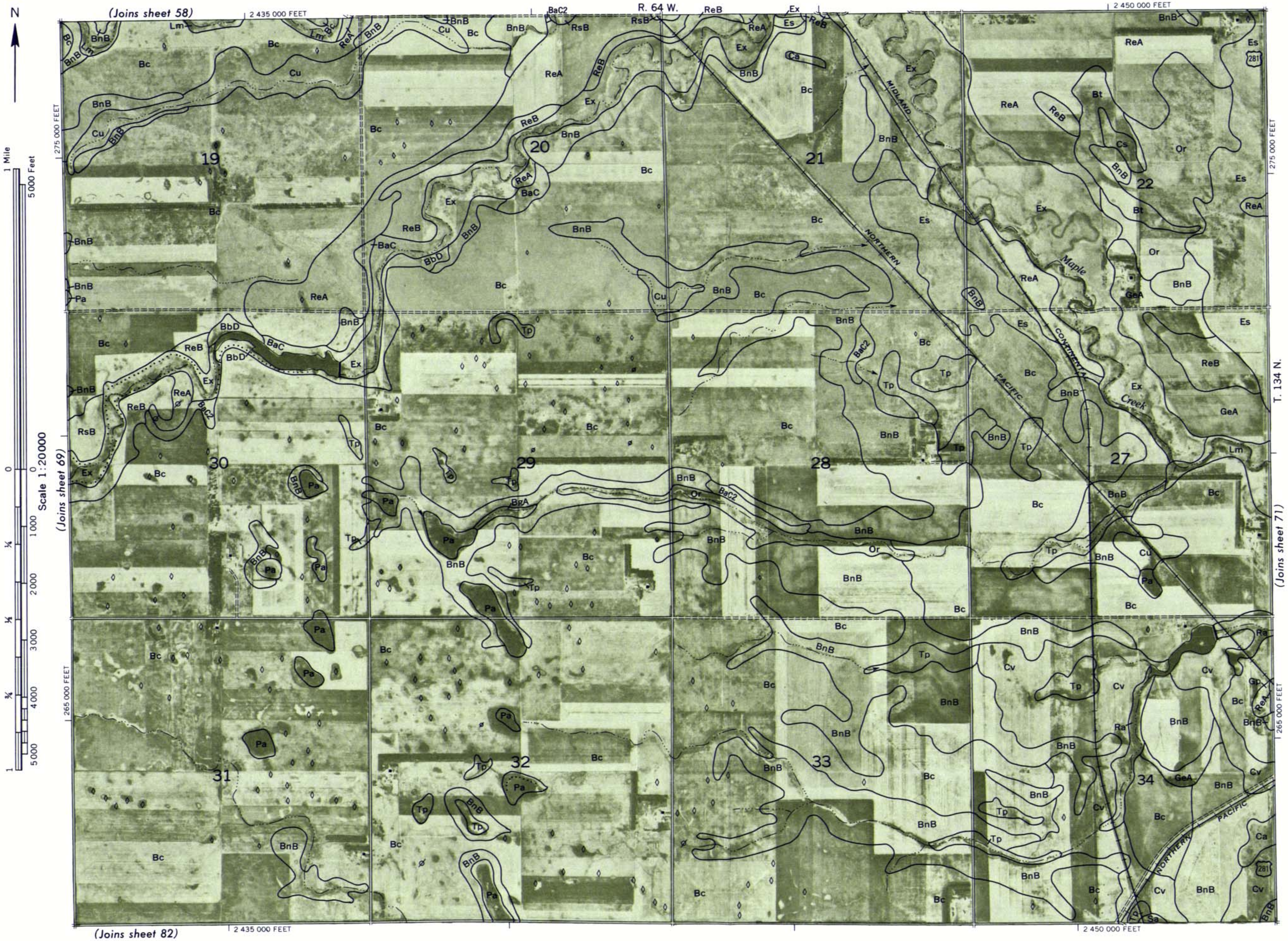
Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 7



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



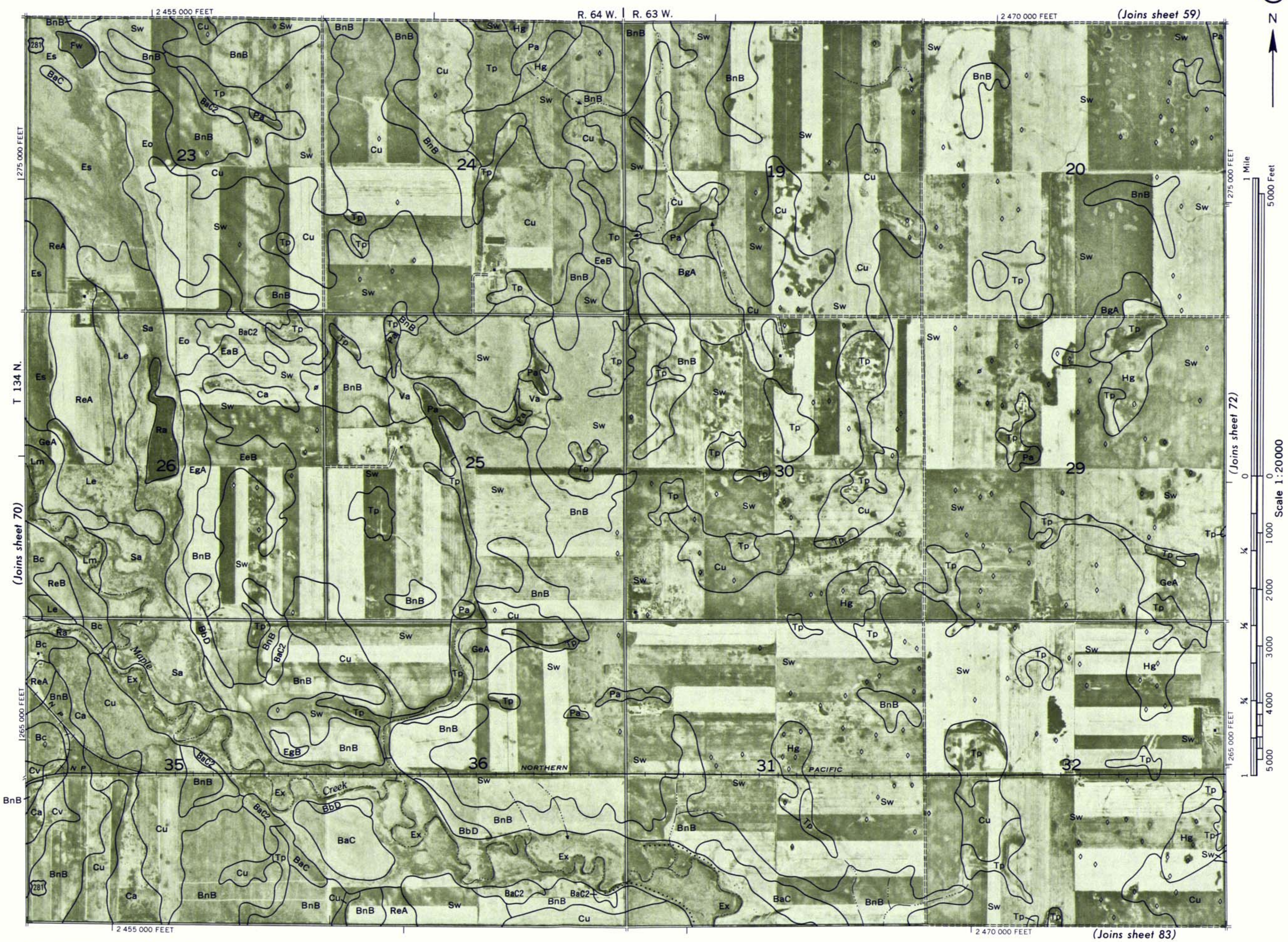
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 70

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

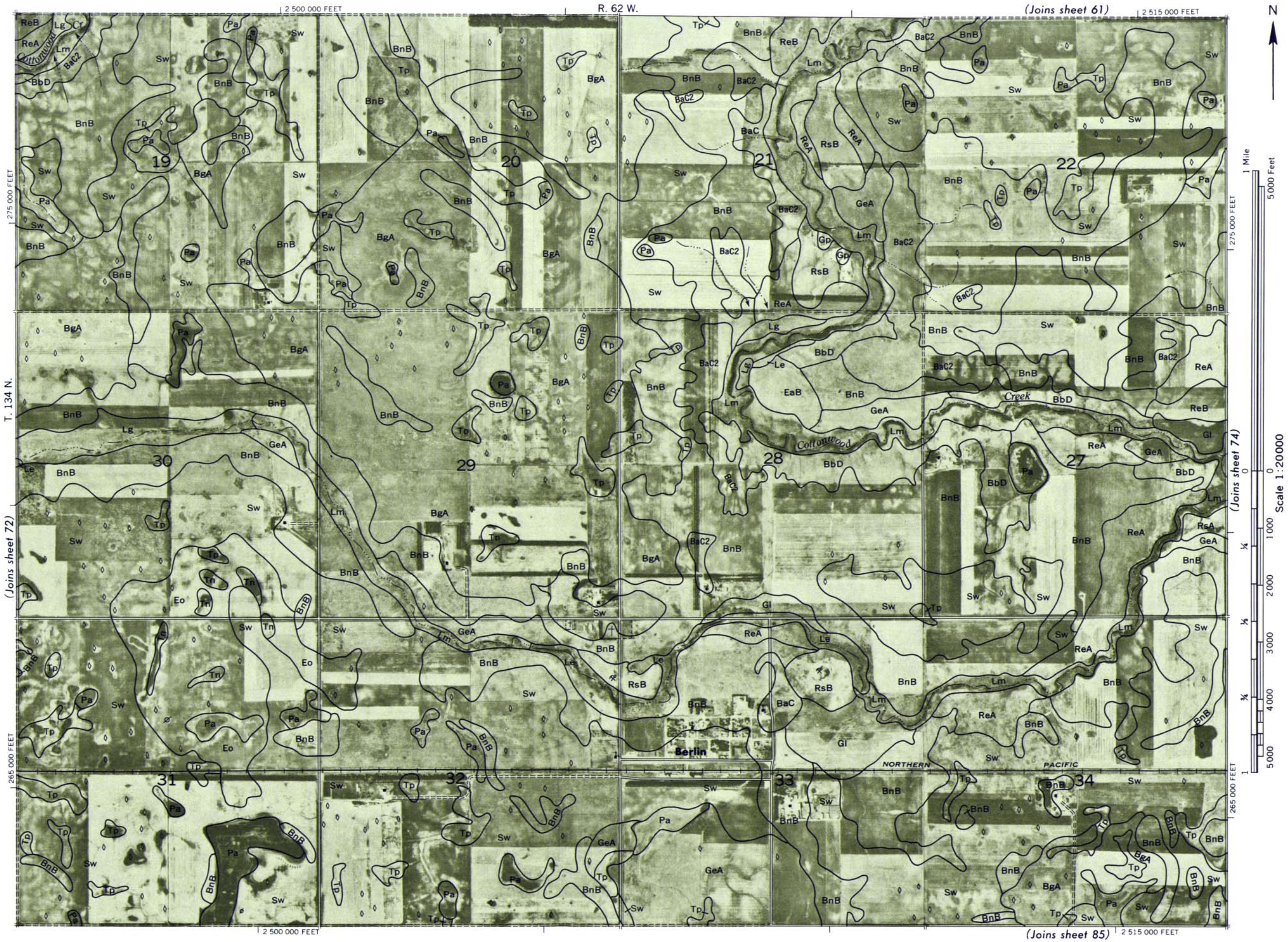
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 72

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 72

Land division corners are approximately positioned on this map.

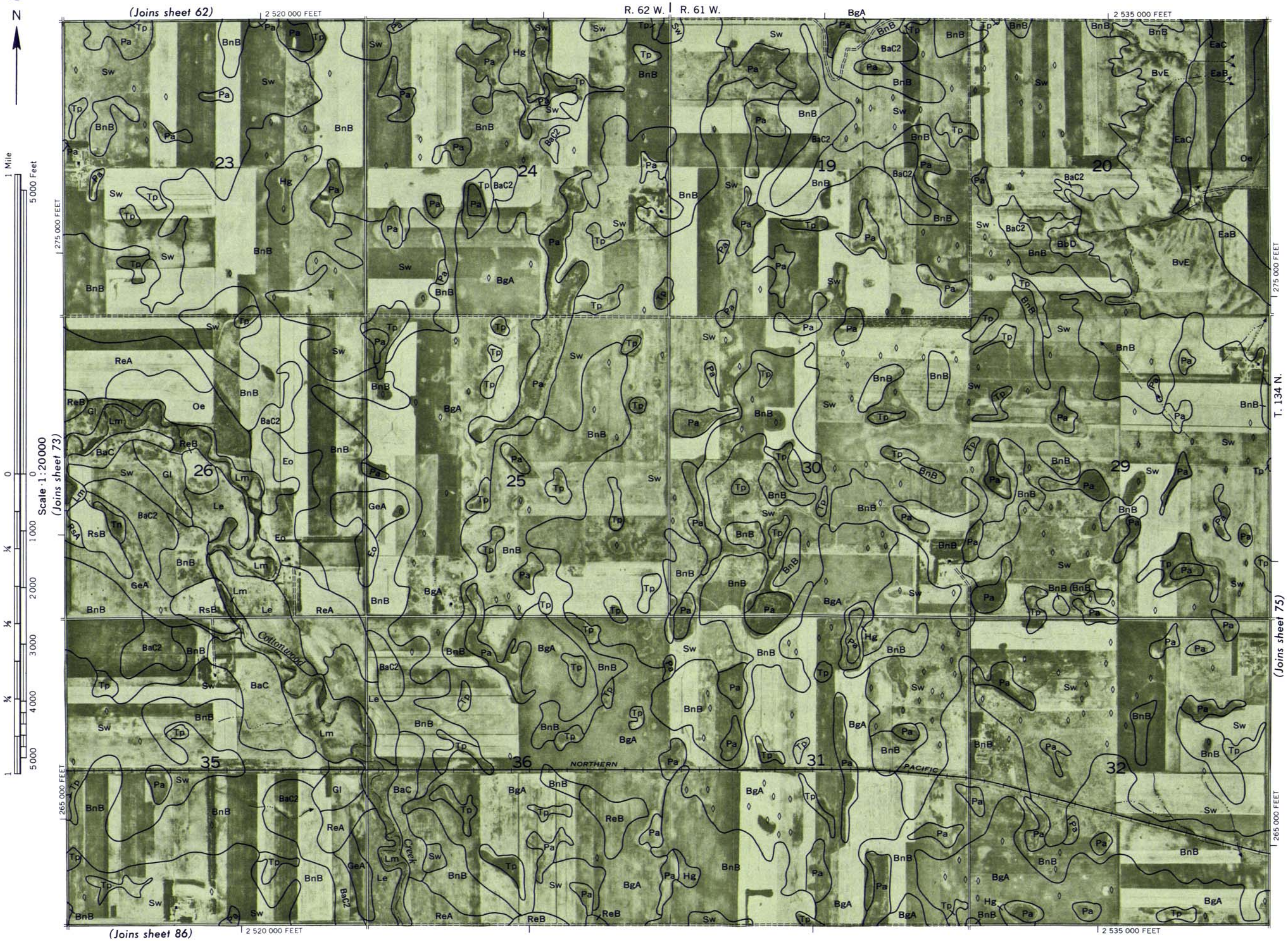
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 74



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 74

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 75

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 76

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

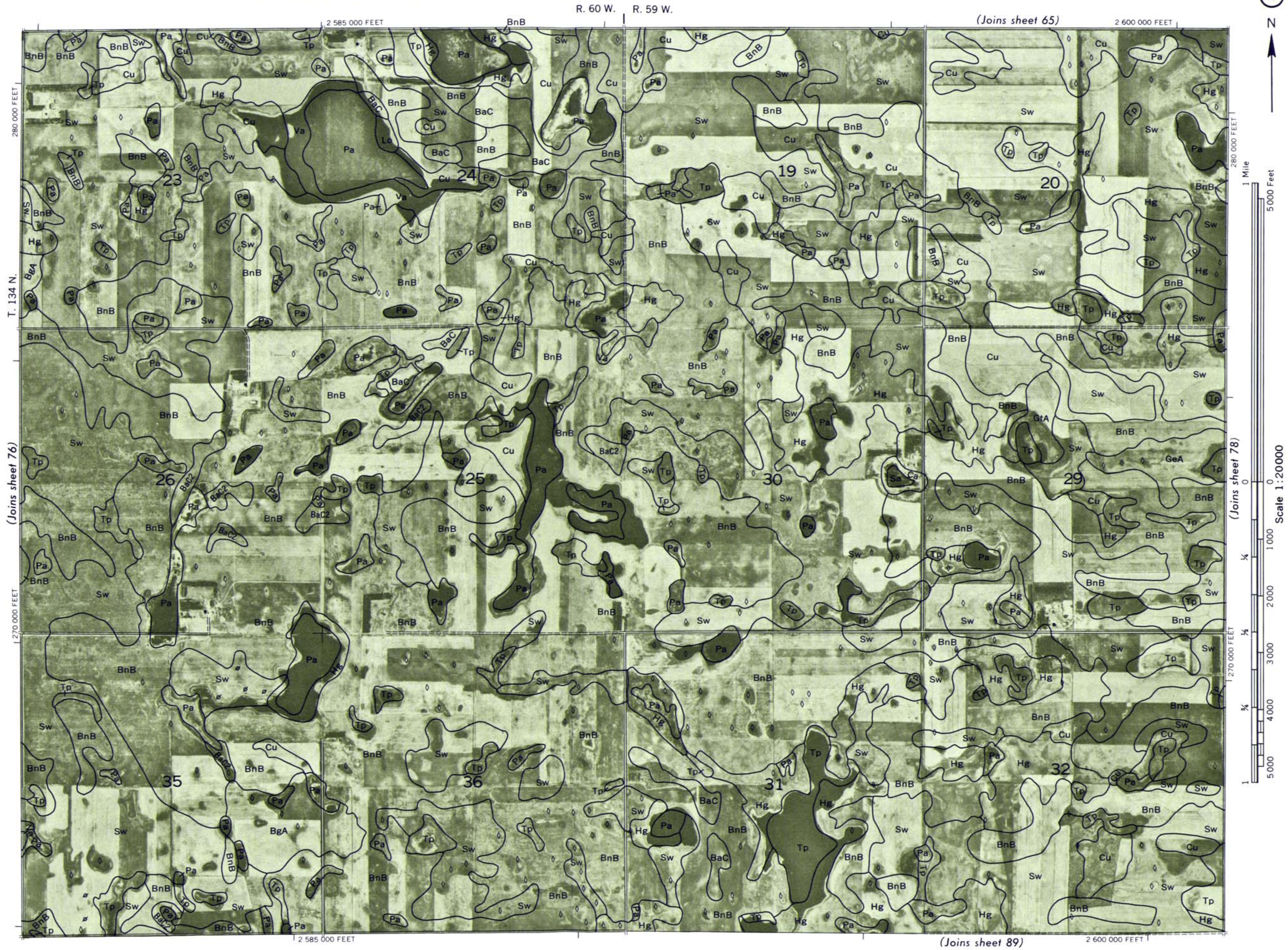
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 76

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

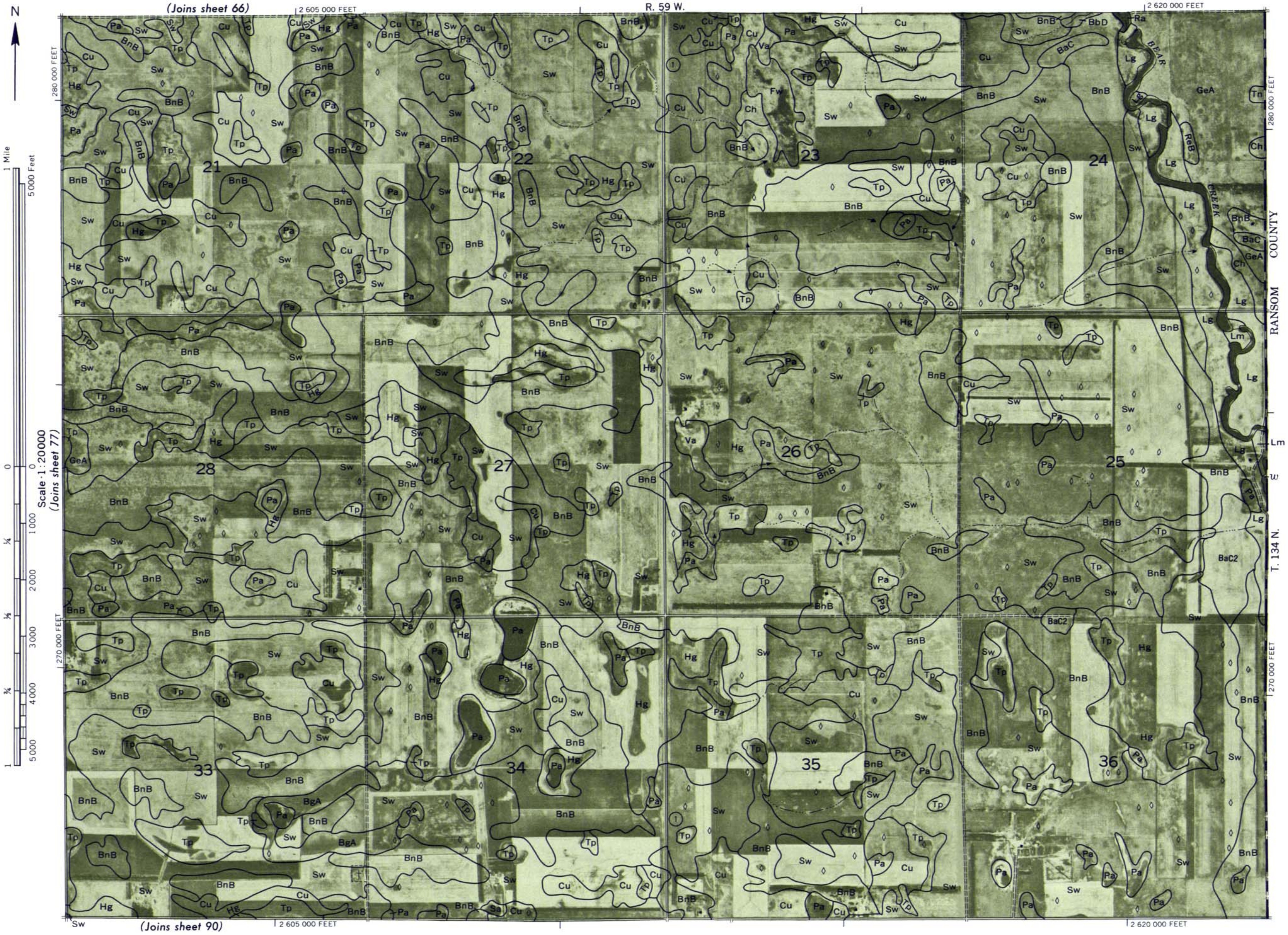
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 77



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 78



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

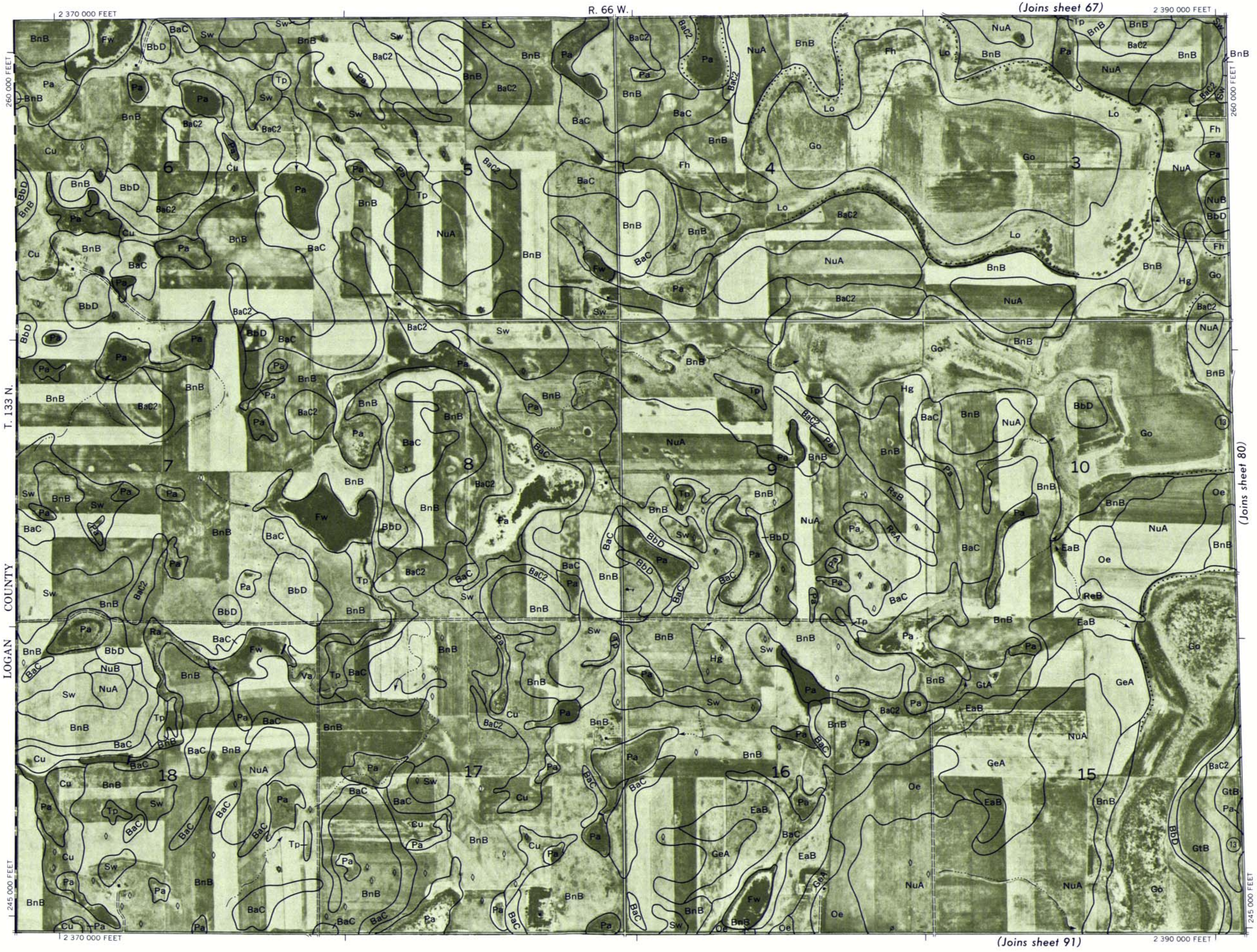
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 78

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

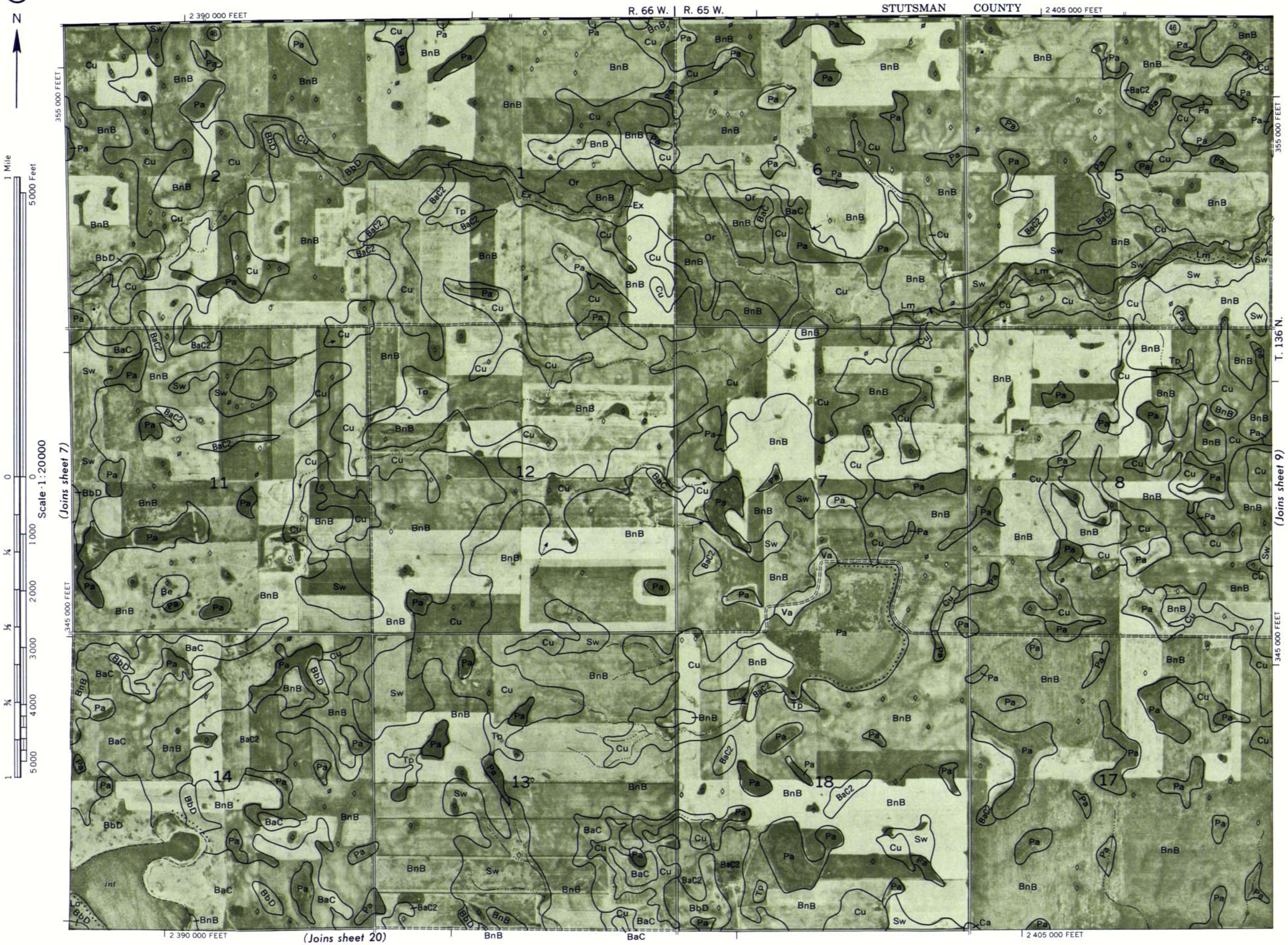
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 79



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system,
south zone. Mosaic compiled from 1964 aerial photographs

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 8



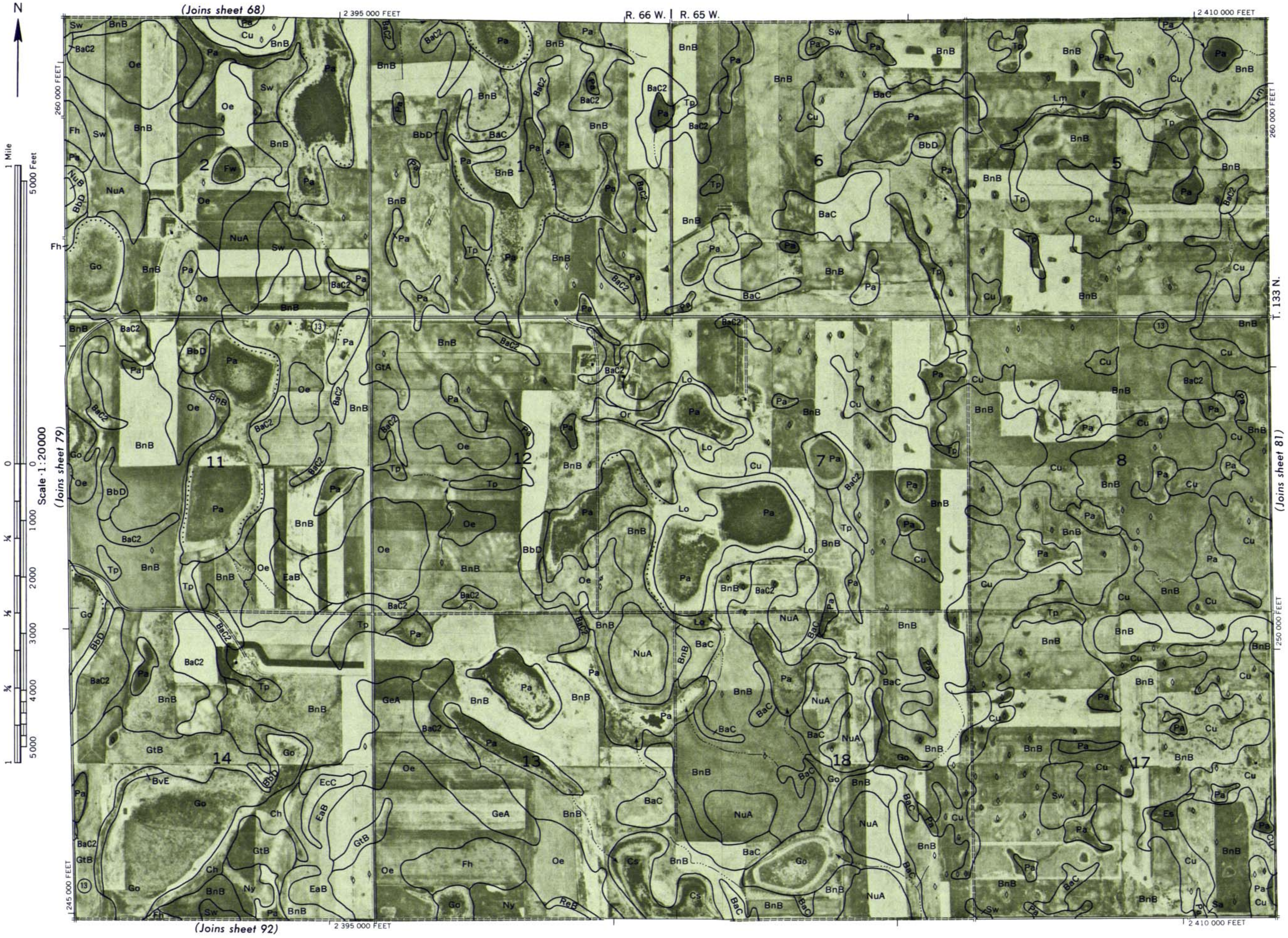
Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 8

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 80



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

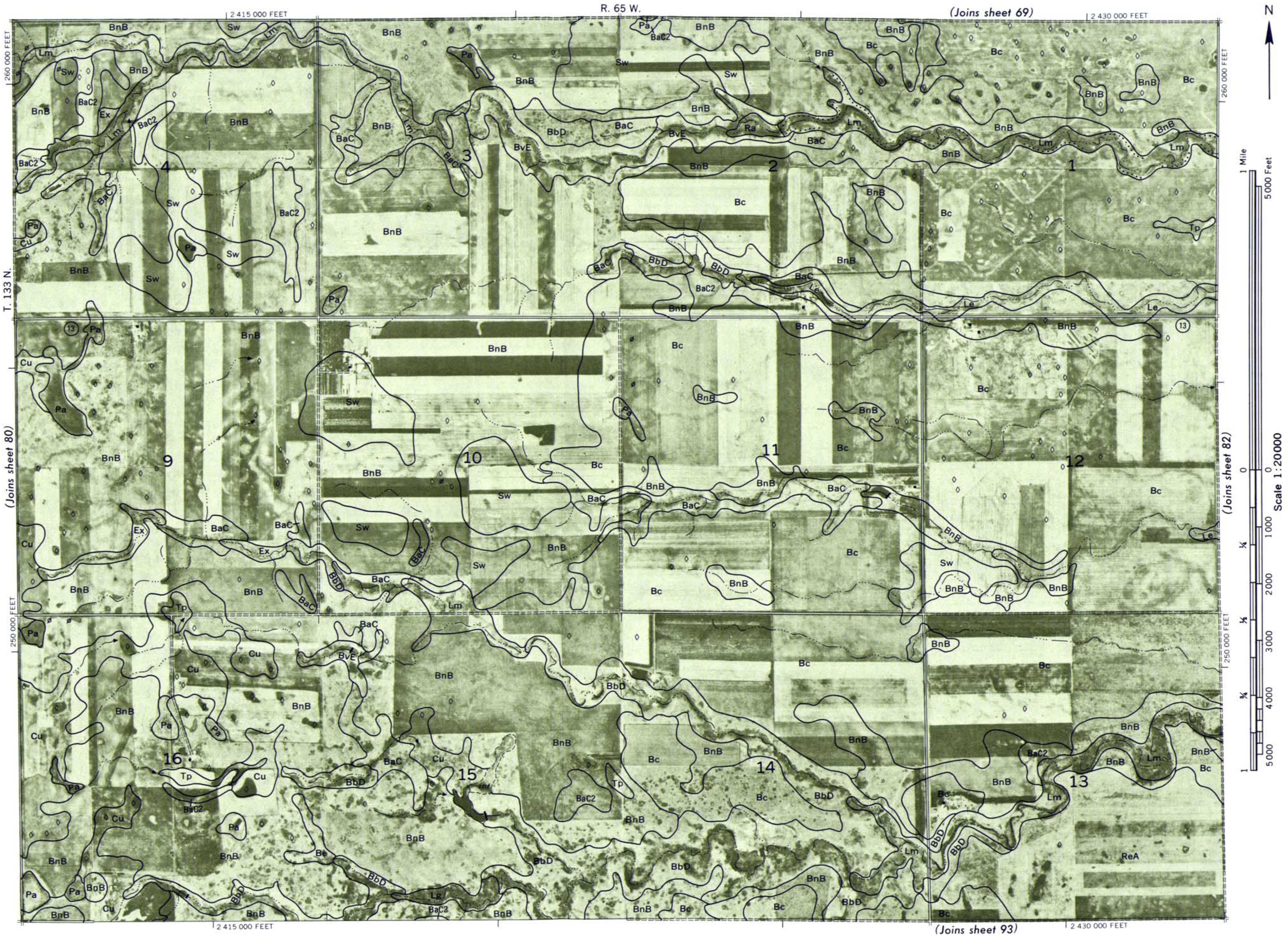
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 80

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

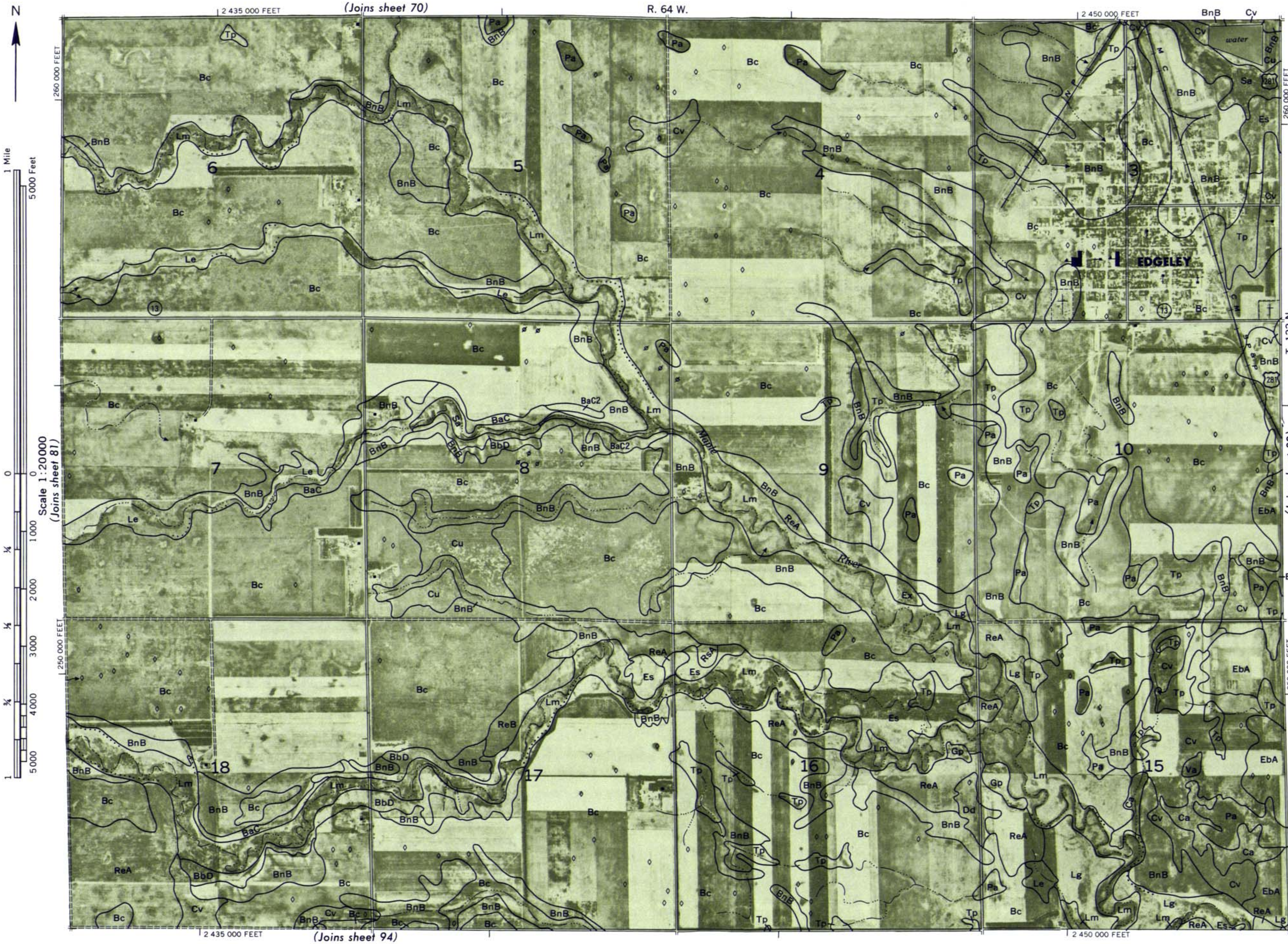
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 81



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 82

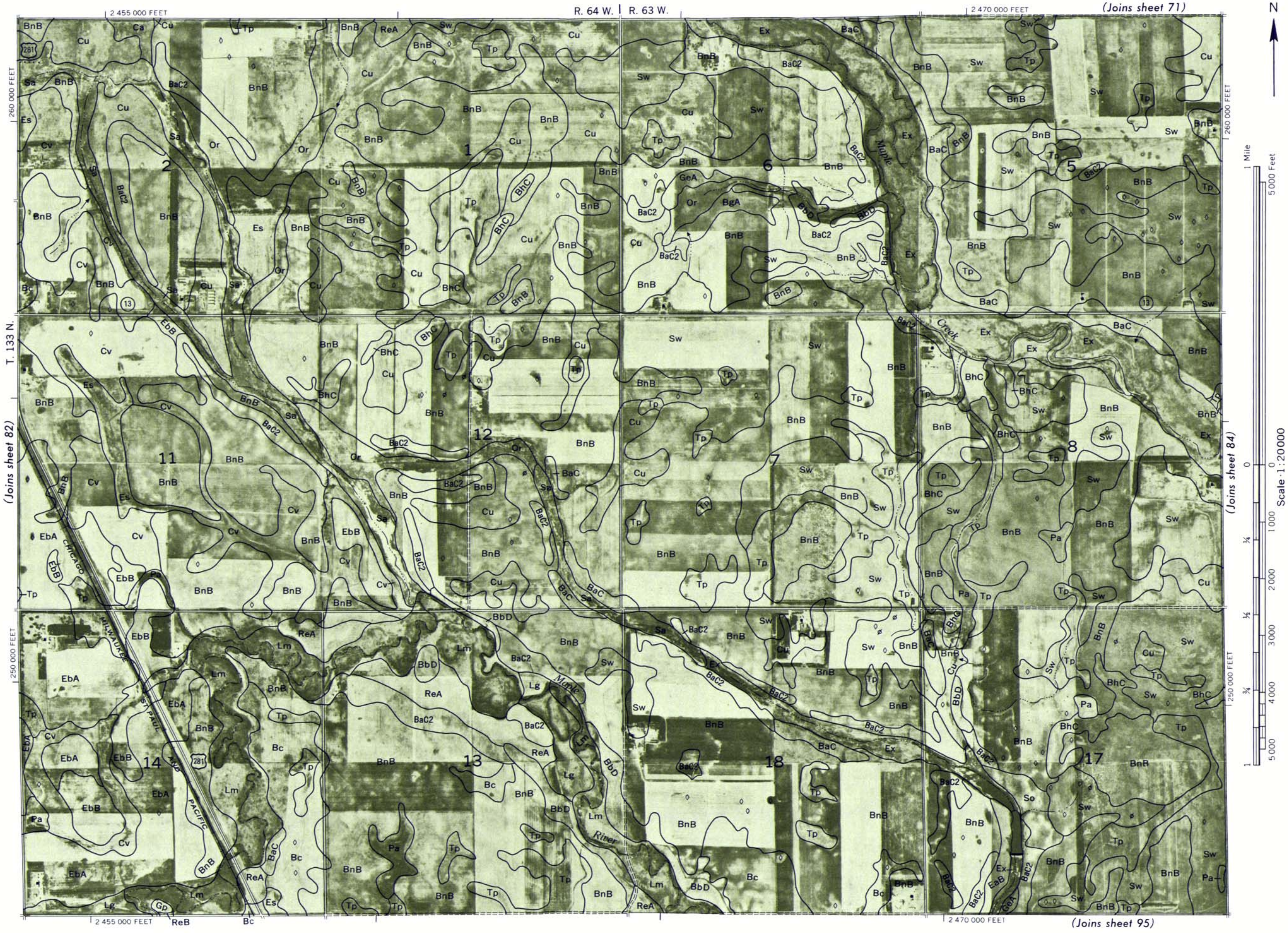


Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 82

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

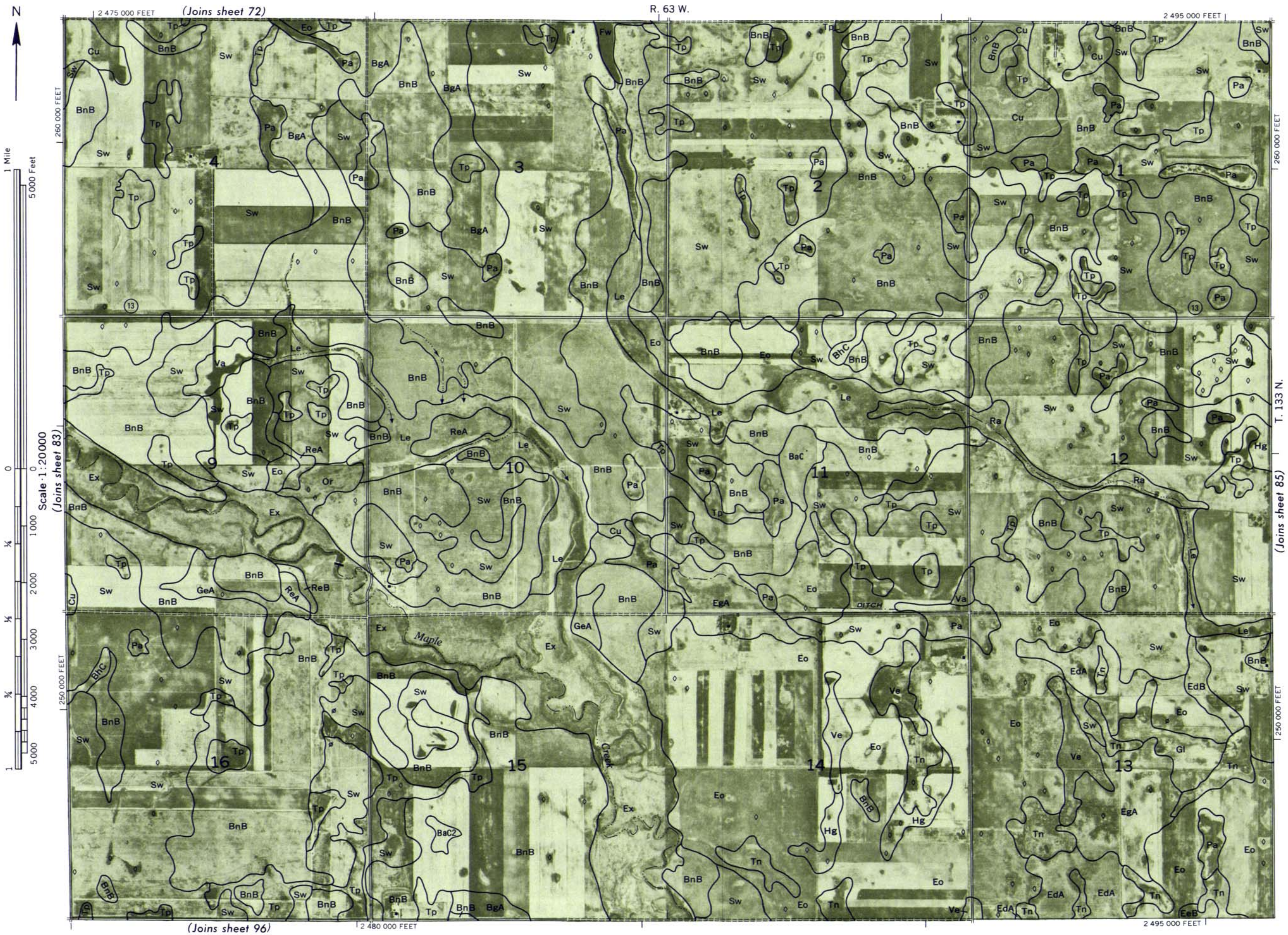


This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 83

Plane coordinate system: 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

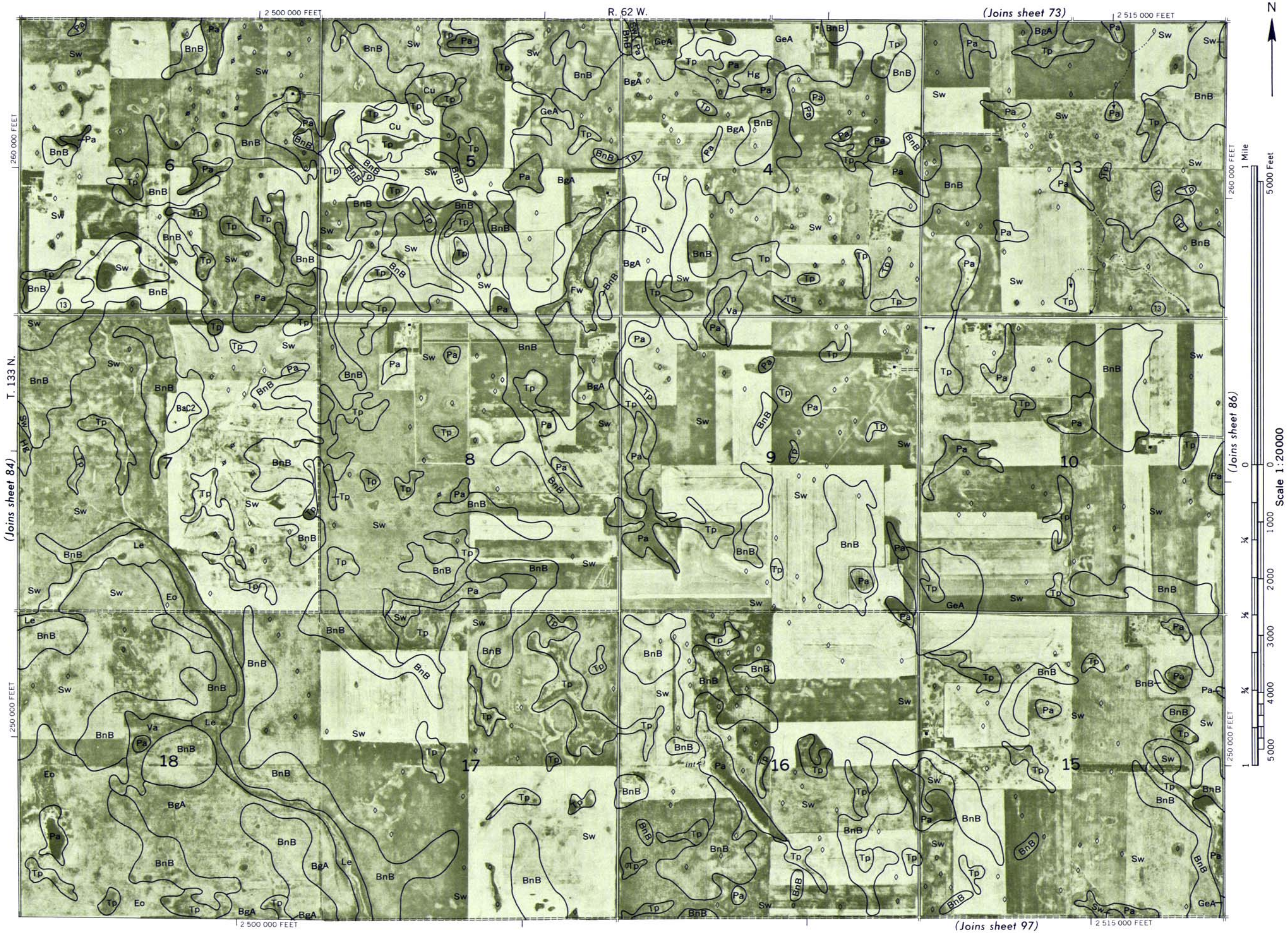
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 84

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 85



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

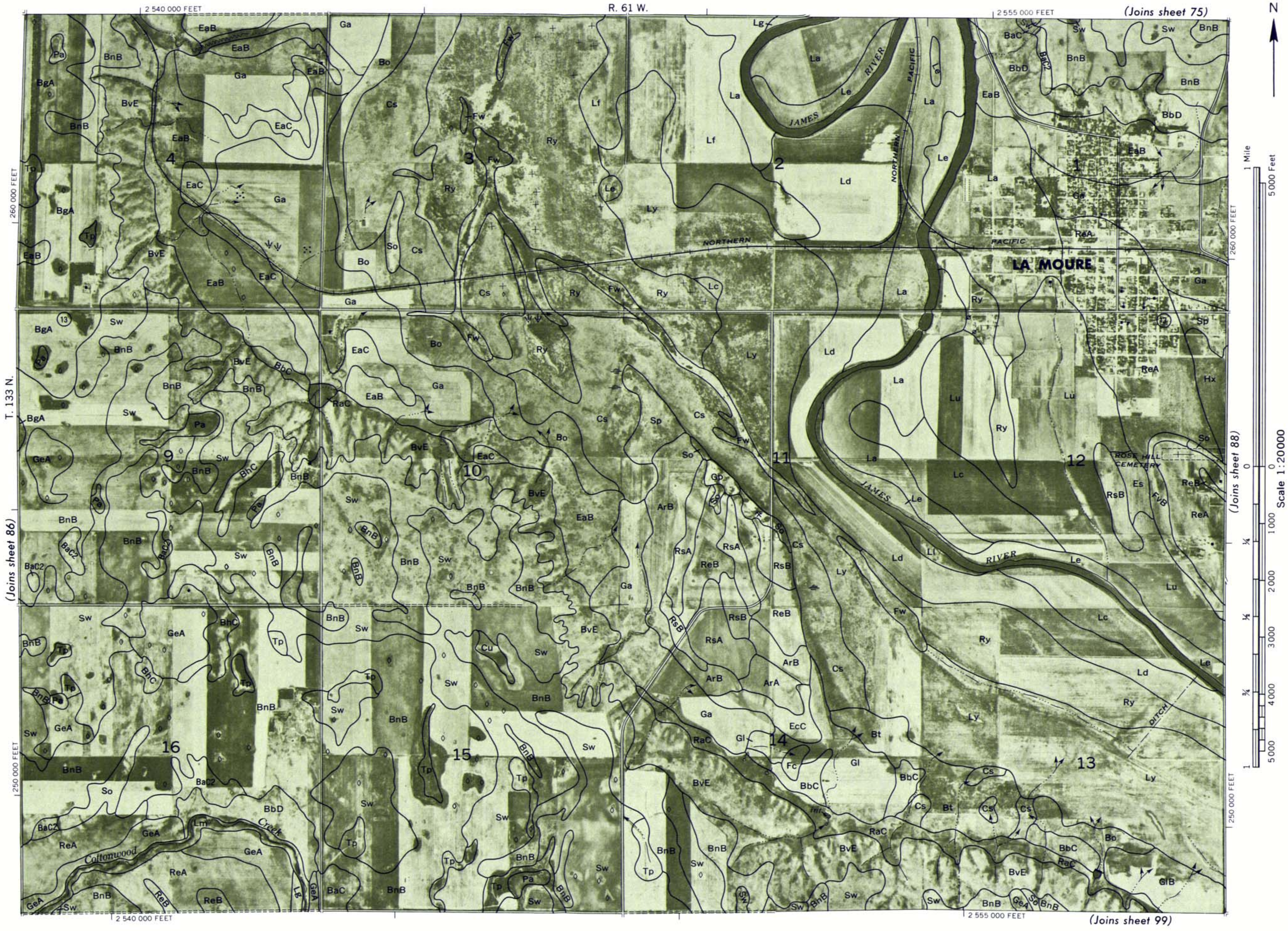
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 86

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

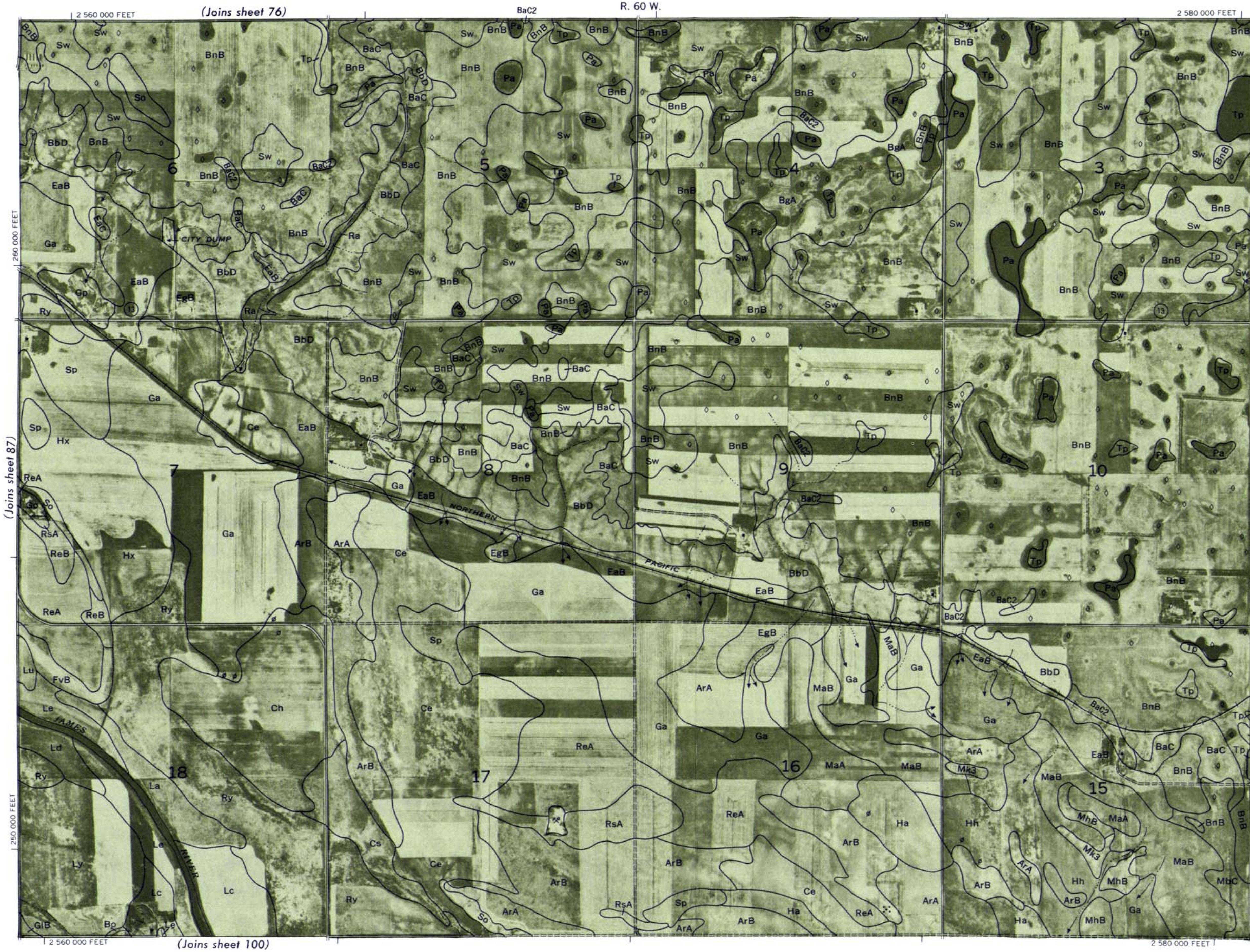
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 88

N

Scale 1:20000

1 Mile | 5000 Feet

0 | 1000 | 2000 | 3000 | 4000 | 5000

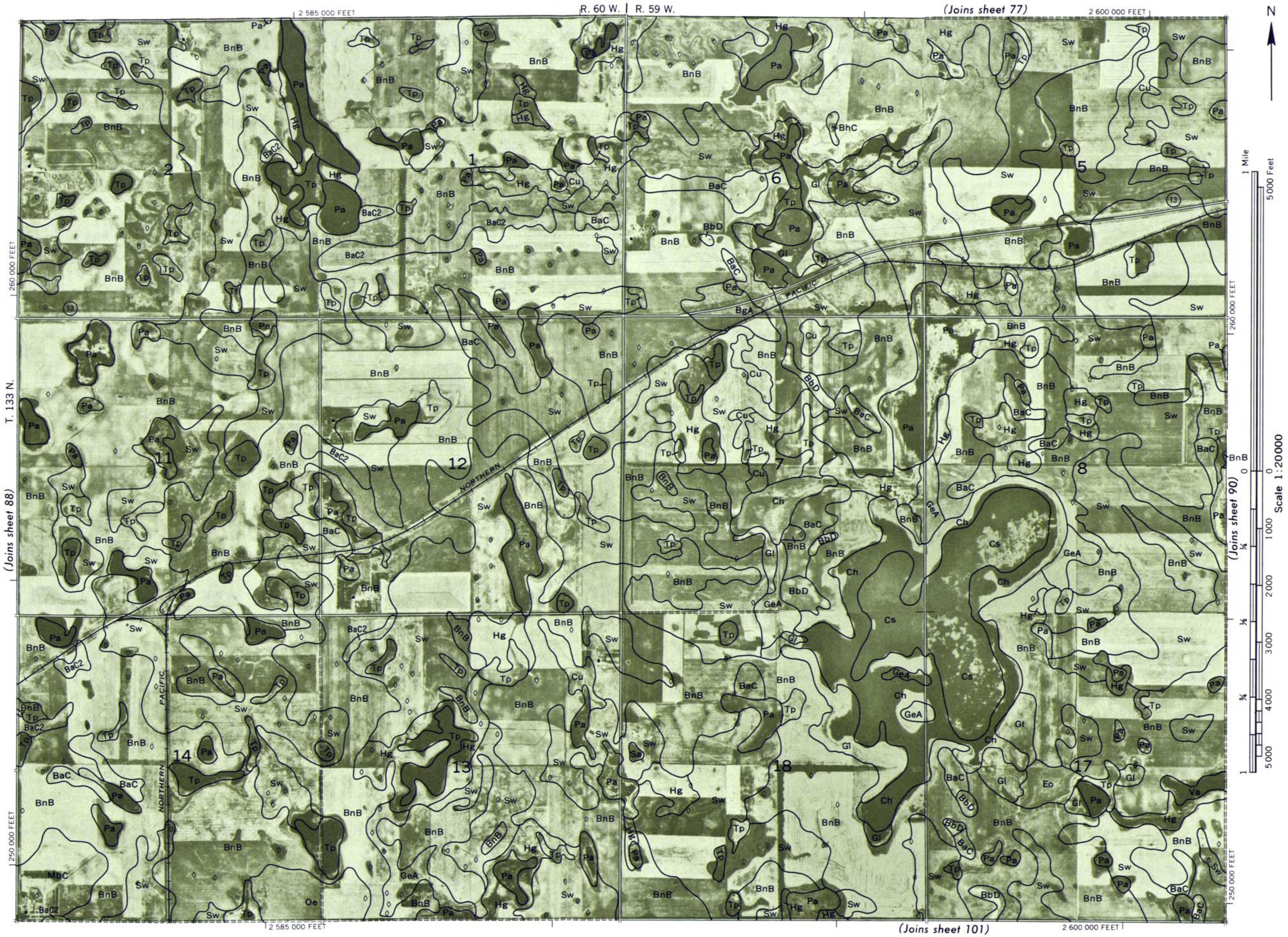


Plane coordinate system, 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 88

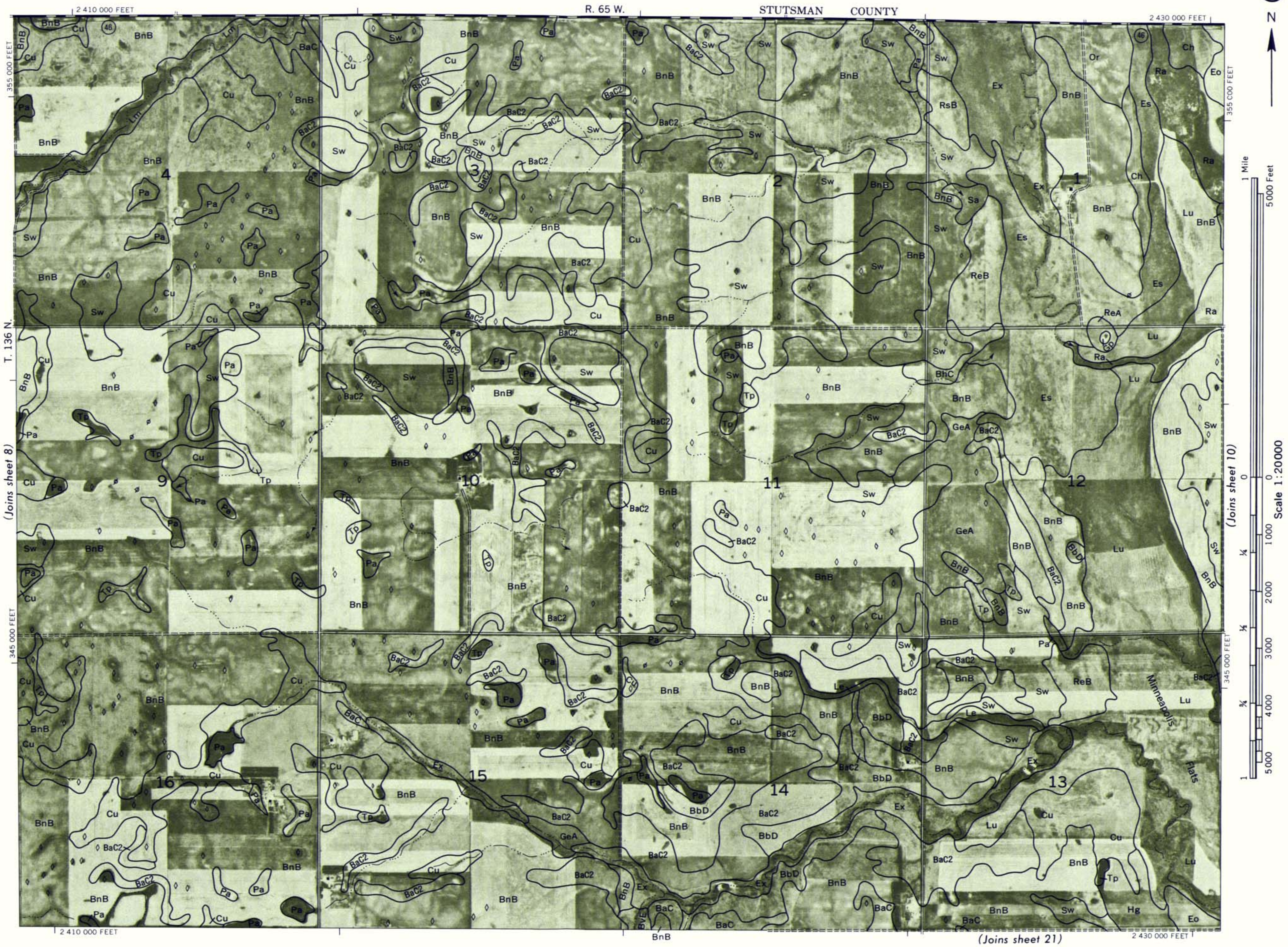
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

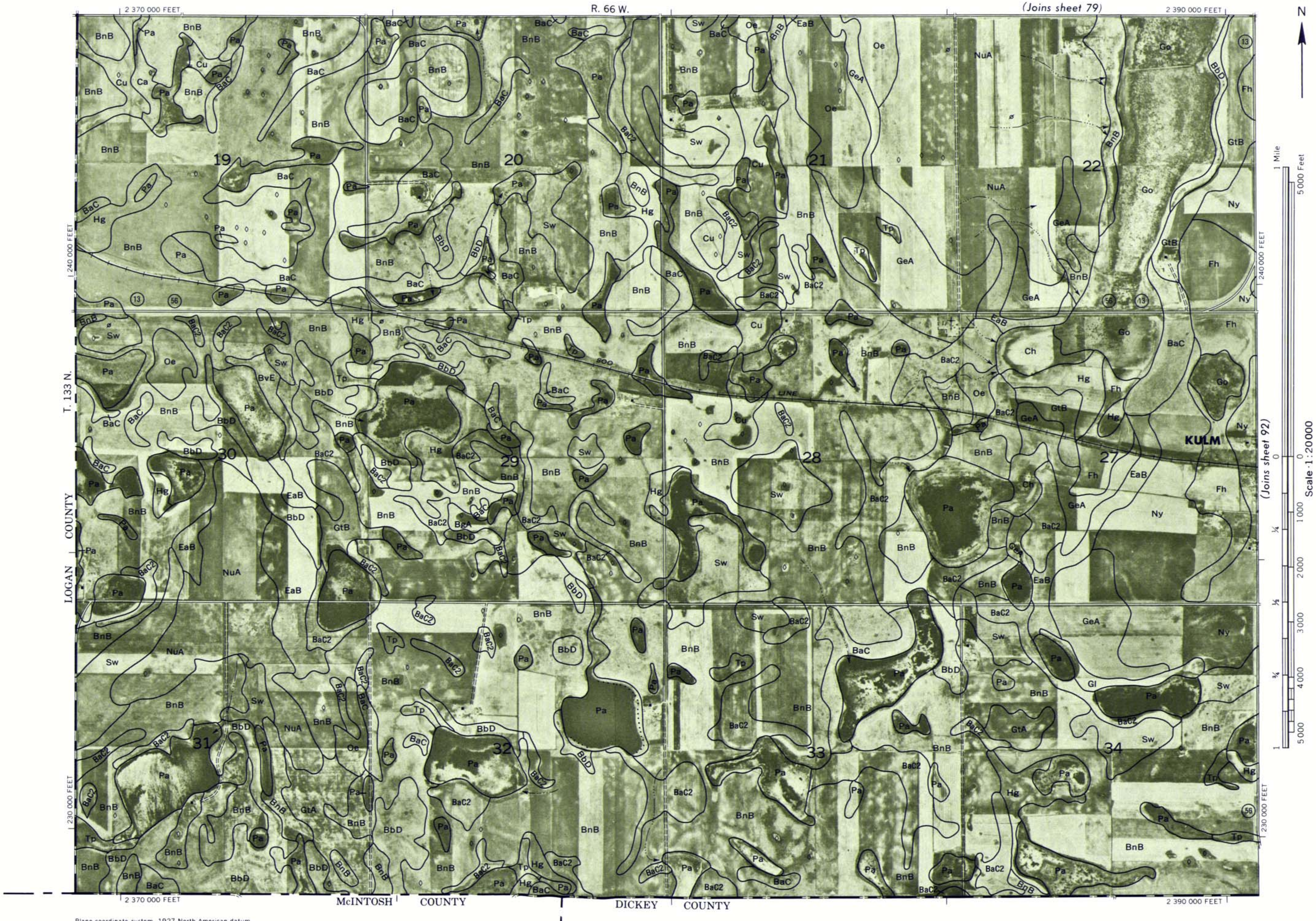
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 90

Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 90

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

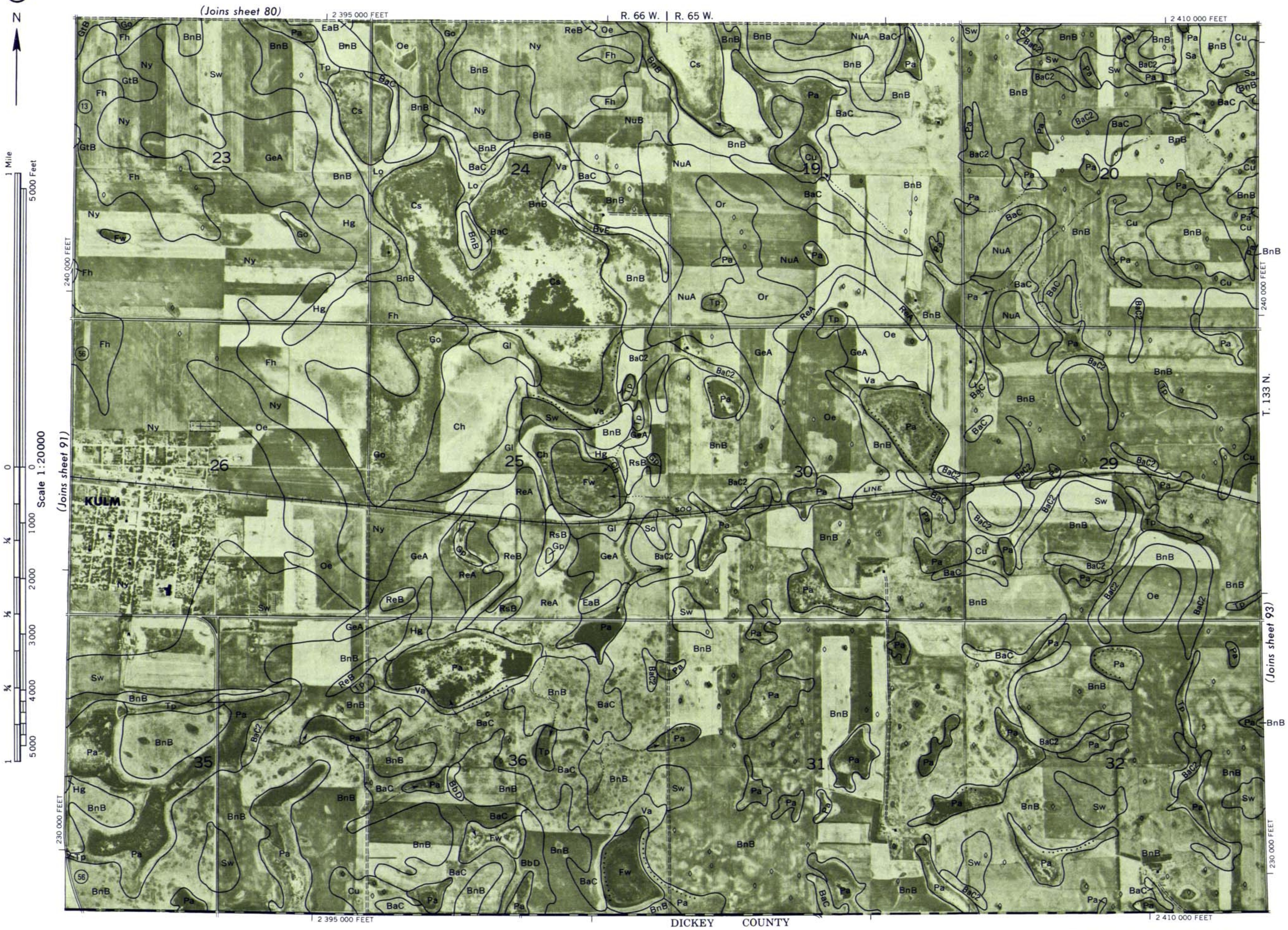


Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 92

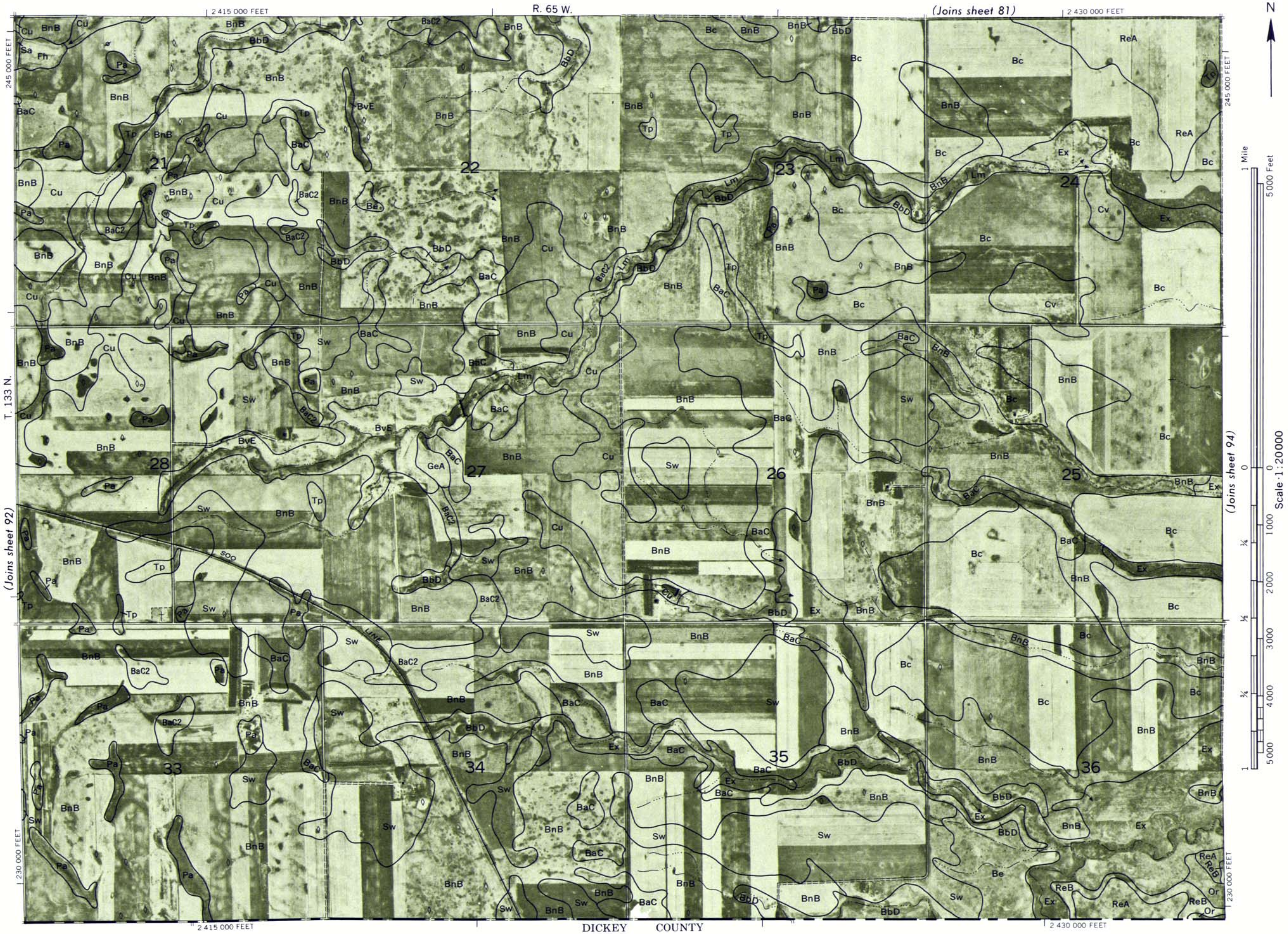


Plane coordinate system. 1927 North American datum. 5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 92

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 93

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 94

N

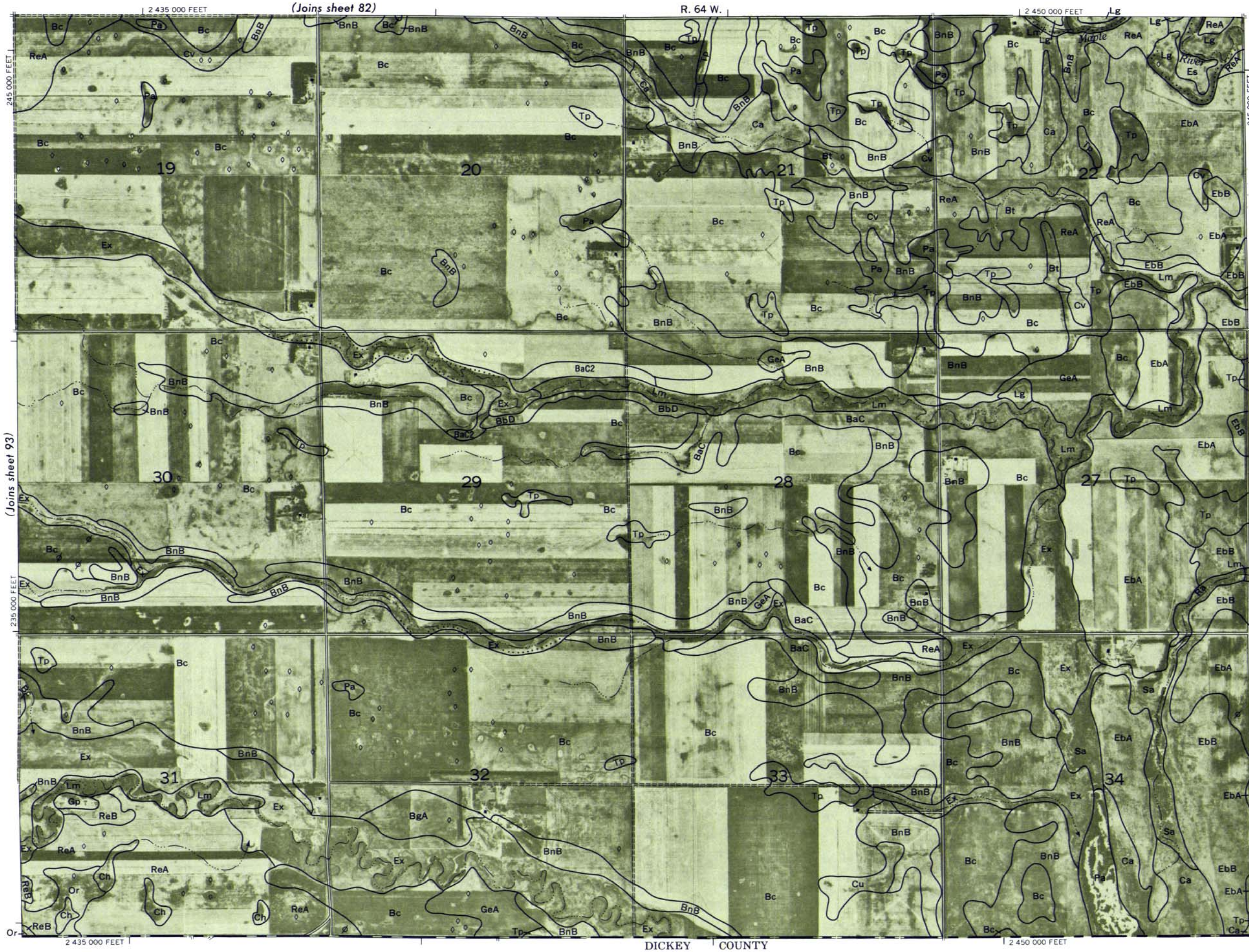
1 Mile

5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

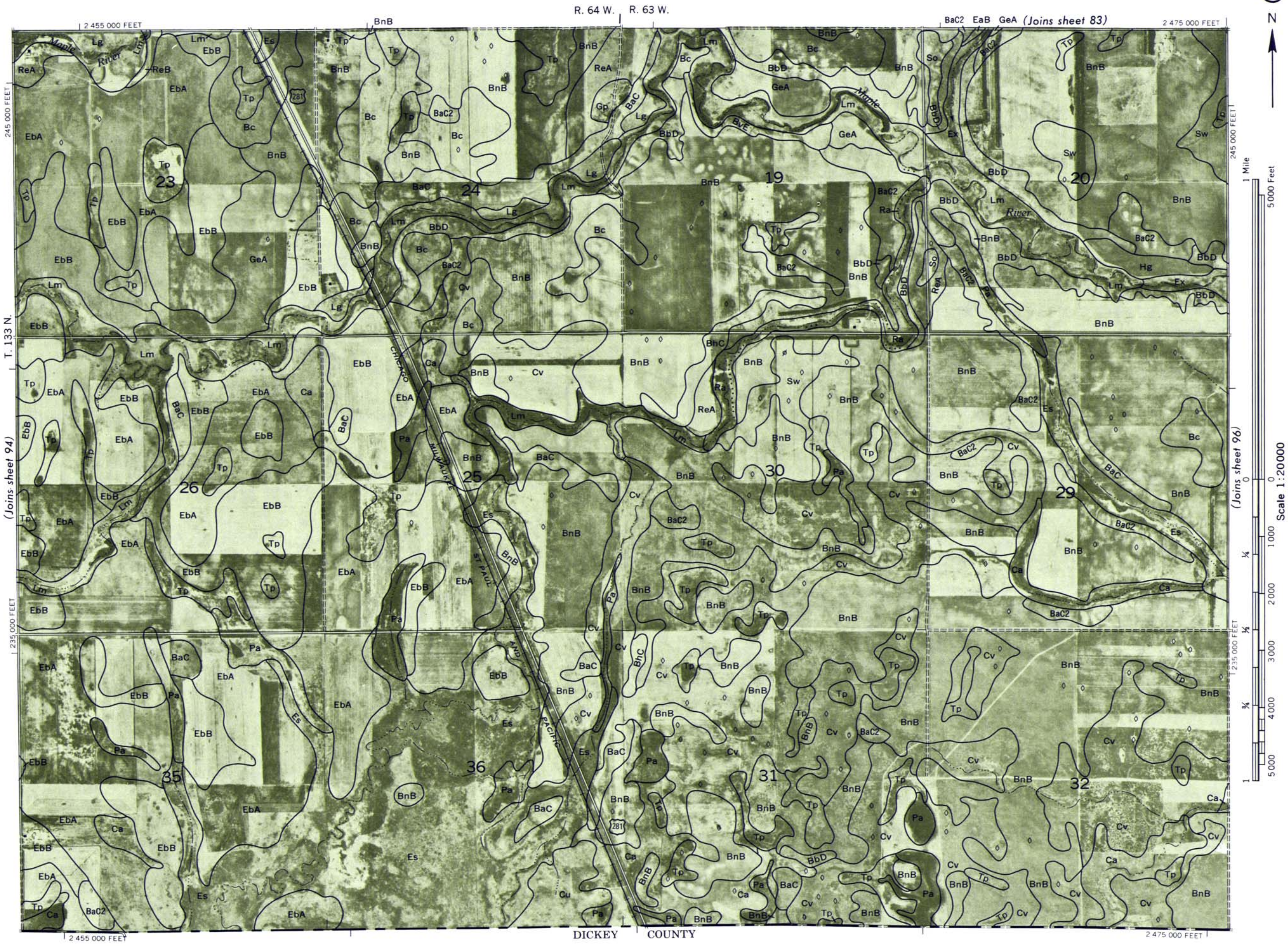


LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 94

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

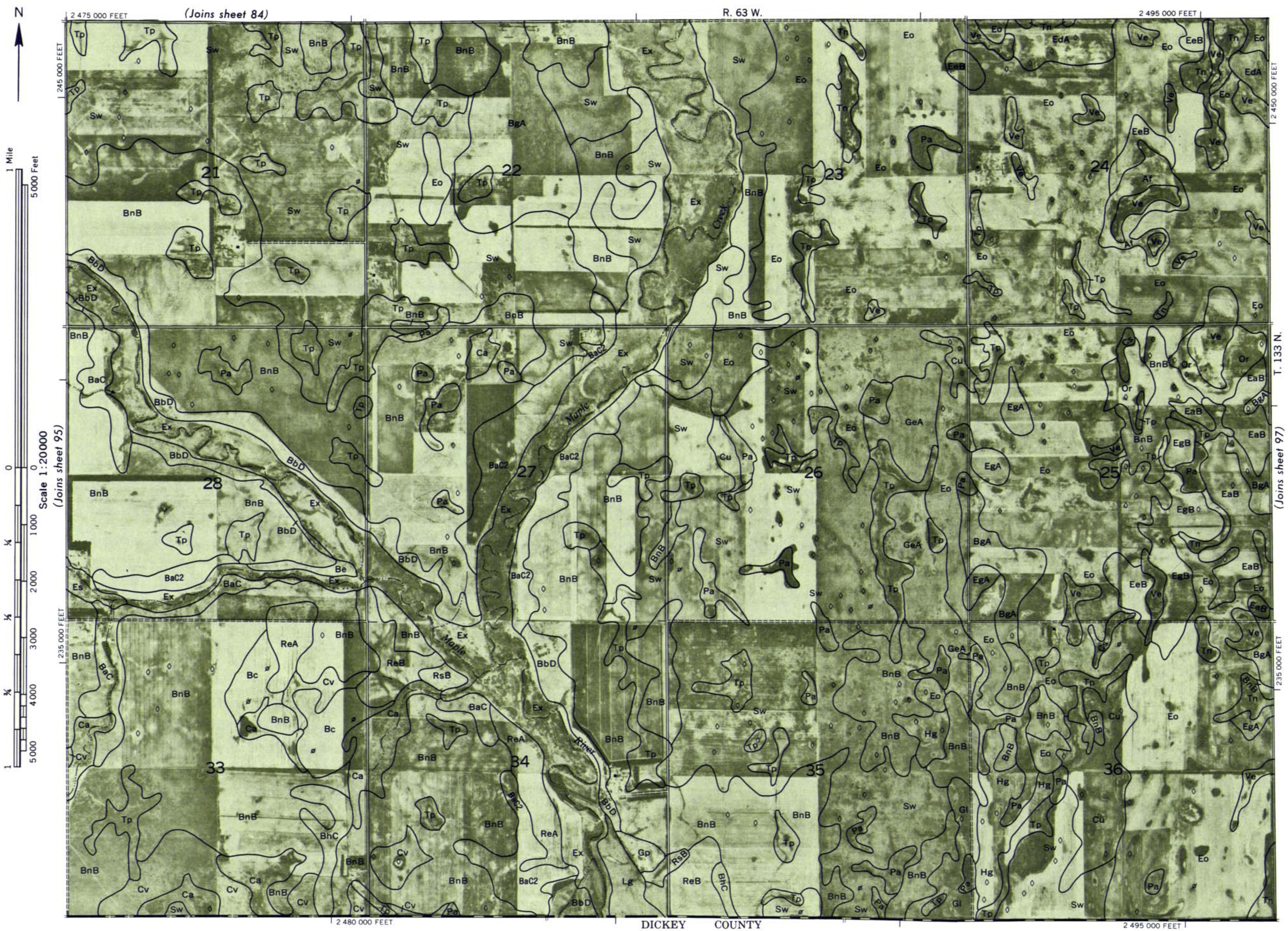
Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 95

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Land division corners are approximately positioned on this map.



LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 96

Land division corners are approximately positioned on this map.

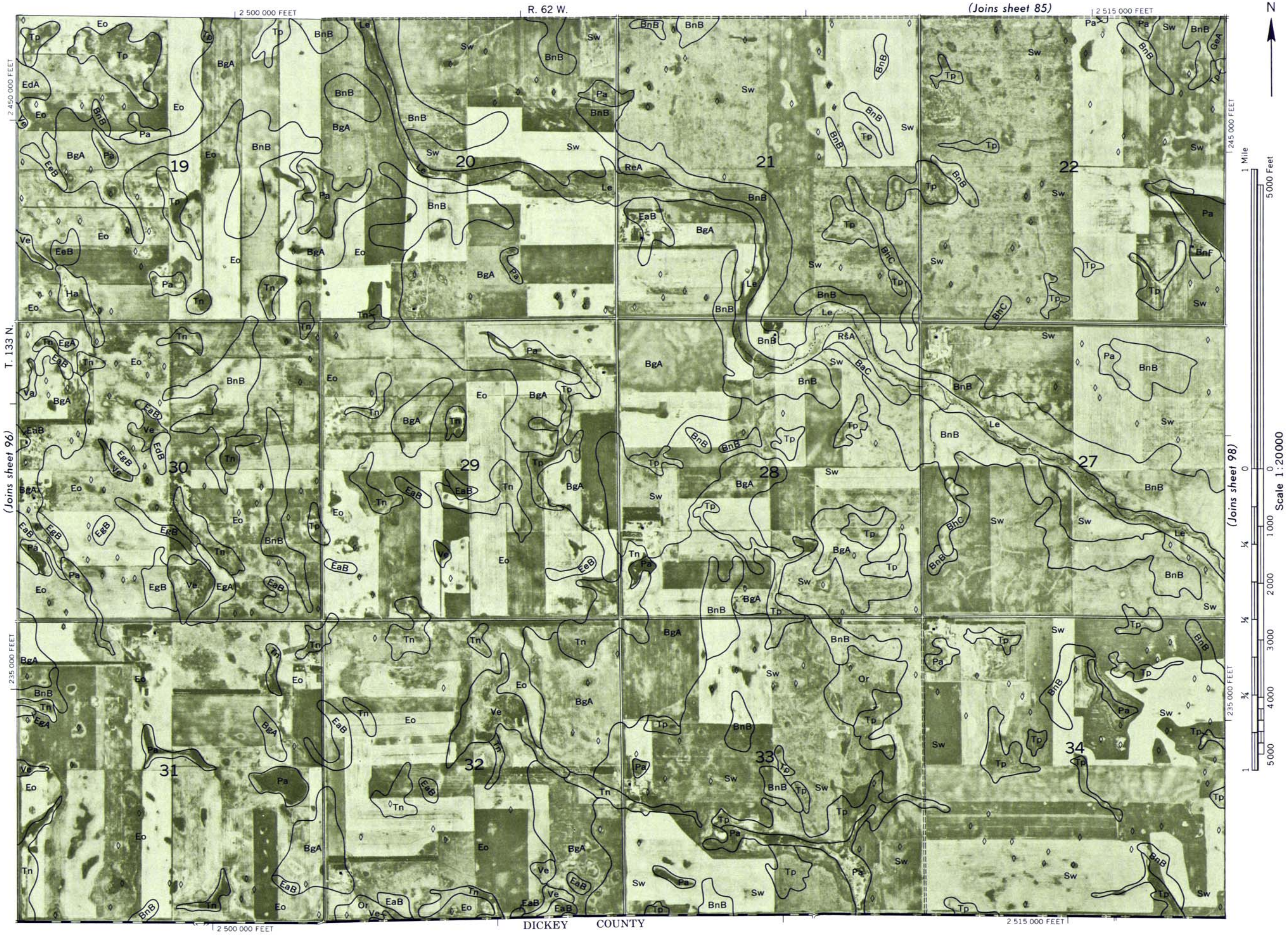
This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 97



Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system,
south zone. Mosaic compiled from 1964 aerial photographs.

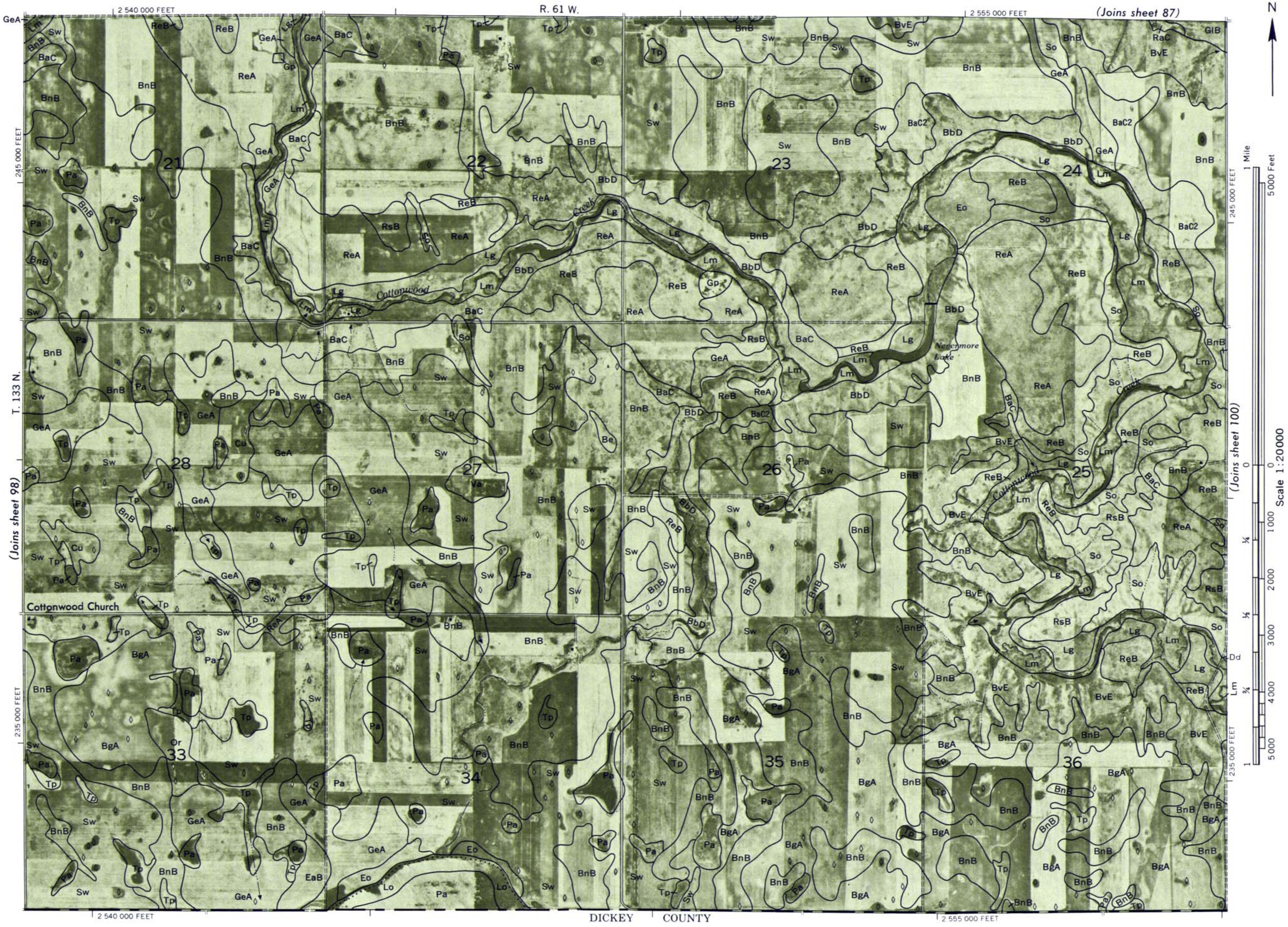
LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA — SHEET NUMBER 98

Plane coordinate system. 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 98

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.



Plane coordinate system, 1927 North American datum.
5,000-foot grid ticks based on North Dakota coordinate system, south zone. Mosaic compiled from 1964 aerial photographs.

This map is one of a set compiled in 1969 as part of a soil survey by the Soil Conservation Service of the United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Land division corners are approximately positioned on this map.

LA MOURE COUNTY AND PARTS OF JAMES RIVER VALLEY, NORTH DAKOTA NO. 99